

# **Bioventing Pilot Test Results Report Liquid Fuel Storage Area, Site ST-12**



**Williams Air Force Base  
Arizona**

Prepared For

**Air Force Center for Environmental Excellence  
Technology Transfer Division  
Brooks Air Force Base  
San Antonio, Texas**

and

**Air Force Base Conversion Agency  
Williams Air Force Base  
Arizona**

April 1997



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**BIOVENTING PILOT TEST RESULTS REPORT**

**Site ST-12  
Liquid Fuels Storage Area**

**Williams Air Force Base, Arizona**

**Prepared for:**

**Air Force Center for Environmental Excellence  
Brooks Air Force Base, Texas**

**and**

**Air Force Base Conversion Agency  
Williams Air Force Base, Arizona**

**April 1997**

**Prepared by:**

**Parsons Engineering Science, Inc.  
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## **SECTION 1**

### **INTRODUCTION**

This report presents the results of a bioventing pilot test performed by Parsons Engineering Science, Inc. (Parsons ES) at Site ST-12, the former Liquid Fuels Storage Area, at Williams Air Force Base (AFB), Arizona. The pilot test was performed to determine the feasibility of bioventing for the remediation of petroleum-contaminated soils at Site ST-12, to determine full-scale bioventing design parameters, and to make recommendations for future remedial action at the site. The scope of work was performed as proposed in the Bioventing Pilot Test Work Plan (Parsons ES, 1996) prepared for Williams AFB and the Air Force Center for Environmental Excellence (AFCEE) Technology Transfer Division (ERT) under Contract F41624-92-D-8036, Order 17. Brief descriptions of the site history, hydrogeology, petroleum hydrocarbon contamination detected during previous investigations, and onsite pilot testing planned by other contractors are described in the work plan, which is included as Appendix A.

Bioventing is one of several remedial technologies that have been tested at the site. Other activities include a natural attenuation study to address dissolved petroleum hydrocarbon contamination in groundwater; bioslurping pilot tests to determine the feasibility of this technology for free-phase product recovery and enhancement of aerobic hydrocarbon biodegradation in soils, periodic free-phase product recovery; and soil vapor extraction (SVE) pilot tests, using both a thermal oxidation unit and an internal combustion engine (ICE) for treatment of extracted vapors to determine the cost-effectiveness of these vapor extraction and treatment technologies for remediating petroleum-impacted vadose zone soils and for removing contaminant mass from free product by stripping volatile constituents. These tests are being conducted under other Air Force contracts, and are not described in this report.

#### **1.1 SUMMARY OF VADOSE ZONE PILOT TESTING ACTIVITIES AT SITE ST-12**

The bioventing pilot test was closely coordinated with an SVE/thermal oxidation pilot test, an SVE/ICE pilot test, and subsequent expanded-scale SVE/ICE system operation at Site ST-12. Because the bioventing pilot test was coordinated with these SVE pilot testing efforts and addressed the same contaminated medium as the SVE pilot tests (i.e., vadose zone soils), a brief overview of the vadose zone pilot testing activities follows.

Drilling and well construction were performed at Site ST-12 from August through early October 1996. A dual-phase extraction (DPE) well and four soil gas monitoring points (MPs), including a background MP, were installed in a cooperative effort

between BEM Systems, Inc. (BEM) and Parsons ES. The DPE well and background MP were installed by BEM in August and September 1996 under their contract with AFCEE (Contract F41624-94-D-8081). Three MPs (MPA, MPB, MPC) were installed by Parsons ES as part of the AFCEE Extended Bioventing Project (Contract F41624-92-D-8036, Order 17) from mid-September through early October 1996. The DPE well was installed by BEM to a total depth of 240 feet below ground surface (bgs), with three discrete screened intervals to allow air injection and soil gas extraction flow rates to be adjusted with depth. Each MP was installed to a total depth of 200 feet bgs, and was screened at eight discrete depths. After the drilling and well/MP installation had been completed, soil gas samples were collected by Parsons ES and analyzed for field and laboratory analytical parameters. Soil gas sampling was performed on 3 October 1996 and was funded under the AFCEE Extended Bioventing Project.

An SVE pilot test using a thermal oxidation treatment unit was then performed at Site ST-12 by BEM from 5 November 1996 through 3 December 1996. Soil vapor was extracted from each DPE well screened interval for approximately 1 week. During this period, changes in vacuum and oxygen, carbon dioxide, and total volatile hydrocarbon (TVH) concentrations were monitored at the MPs. TVH concentrations in the soil gas samples recovered from the lower and middle screen intervals were more than sufficient to keep the thermal oxidation unit running without using supplemental fuel. TVH concentrations in the soil gas from the upper screen were insufficient to keep the unit running without using excessive amounts of supplemental fuel, so soil gas was extracted from all intervals simultaneously for the last week of testing.

It was anticipated that the SVE pilot test by BEM would sufficiently increase oxygen concentrations at the MPs so that a bioventing respiration test could be conducted by Parsons ES immediately after the SVE pilot test was completed. However, during soil gas sampling performed by Parsons ES on 4 December 1996, 1 day following the completion of the SVE pilot test, only two shallow MP screens at 25 feet bgs and two MP screens installed in an apparently permeable zone at 175 feet bgs contained oxygen concentrations high enough to allow a respiration test to be performed. Therefore, it was decided to perform the air permeability test by injecting air into the DPE well as described in the work plan (Appendix A), and to perform an area-style respiration test after the soils had been oxygenated during the air permeability test. The air permeability test was performed on 5 and 6 December 1996. Air was injected into the DPE well using a 2-horsepower regenerative blower for a 24-hour period, while changes in pressure and soil gas chemistry were monitored at the MPs. Oxygen response was achieved at a number of MP screens, and an area-style respiration test was conducted following the air permeability test. The respiration test was performed by stopping air injection at the DPE well on 6 December 1996, and monitoring biological oxygen utilization and other changes in soil gas chemistry in a series of soil gas sampling events conducted until 31 December 1996, when the test was completed.

Results of the SVE and bioventing pilot testing indicated that SVE would be a more appropriate technology for the remediation of vadose zone soils at Site ST-12 than bioventing. Respiration testing showed that fuel biodegradation rates were below 100 milligrams of fuel consumed per kilogram of soil per year in the deeper, most contaminated portions of the vadose zone. TVH concentrations in soil vapors were also elevated at Site ST-12, with readings as high as 290,000 parts per million, volume per

volume (ppmv). Because biodegradation rates were low and TVH levels were elevated, the decision was made to implement additional SVE activities at the site.

A VR Systems, Inc. Model V4 ICE unit was installed by Parsons ES at Site ST-12 in February 1997, under contract to AFCEE as part of the ICE Demonstration Project, to determine if this technology would be cost effective for the removal and destruction of hydrocarbon vapors in the subsurface. Initial system operation was successful, with the average removal of 480 gallons of petroleum hydrocarbons per day from the DPE well when the ICE unit was fully operational. In April 1997, a second Model V4 ICE unit was installed at the site, and hydrocarbons will be removed from the DPE well using both ICE units until system operation and hydrocarbon recovery using both units is no longer economical. At that time, it is anticipated that one ICE unit will continue extracting vapors from the DPE well and one ICE unit will be moved to well N-6 at Site ST-12 for vapor extraction. No further bioventing activities are planned for the site.

## **1.2 REPORT ORGANIZATION**

This document is organized into six sections, including this introduction, and three appendices. Section 2 presents the bioventing pilot testing design and construction details. Section 3 describes the soil and soil gas sampling results, and also describes deviations from the AFCEE bioventing protocol document (Hinchey et al., 1992) and the pilot test work plan (Appendix A). Section 4 presents the results of the bioventing pilot test, and recommendations for future remedial action at the site are presented in Section 5. Section 6 presents the references cited in this document. Appendix A is a copy of the bioventing pilot testing work plan. Appendix B includes the borehole logs. Appendix C contains the analytical sample chain-of-custody forms and laboratory analytical results for samples collected during this effort.

## SECTION 2

### PILOT TEST DESIGN AND CONSTRUCTION

The installation of a DPE well and four soil gas MPs (including a background MP) was completed from August 1996 through early October 1996. Drilling, DPE well installation, and MP installation were performed as a cooperative effort between BEM and Parsons ES. The DPE well and background MP were installed by BEM under their contract with AFCEE. Three MPs (MPA, MPB, MPC) were installed by Parsons ES under the AFCEE Extended Bioventing Project (Contract F41624-92-D-8036, Order 17). Drilling services for both the BEM and Parsons ES drilling scopes of work were provided by Layne Christensen Company of Tempe, Arizona. DPE well and soil gas MP locations are shown on Figure 2.1. The hydrogeology of the site is depicted on the cross-section provided in Figure 2.2. Borehole logs for the DPE well and soil gas MPs are included in Appendix B. The following sections describe the final design and installation of the pilot-scale bioventing system at Site ST-12.

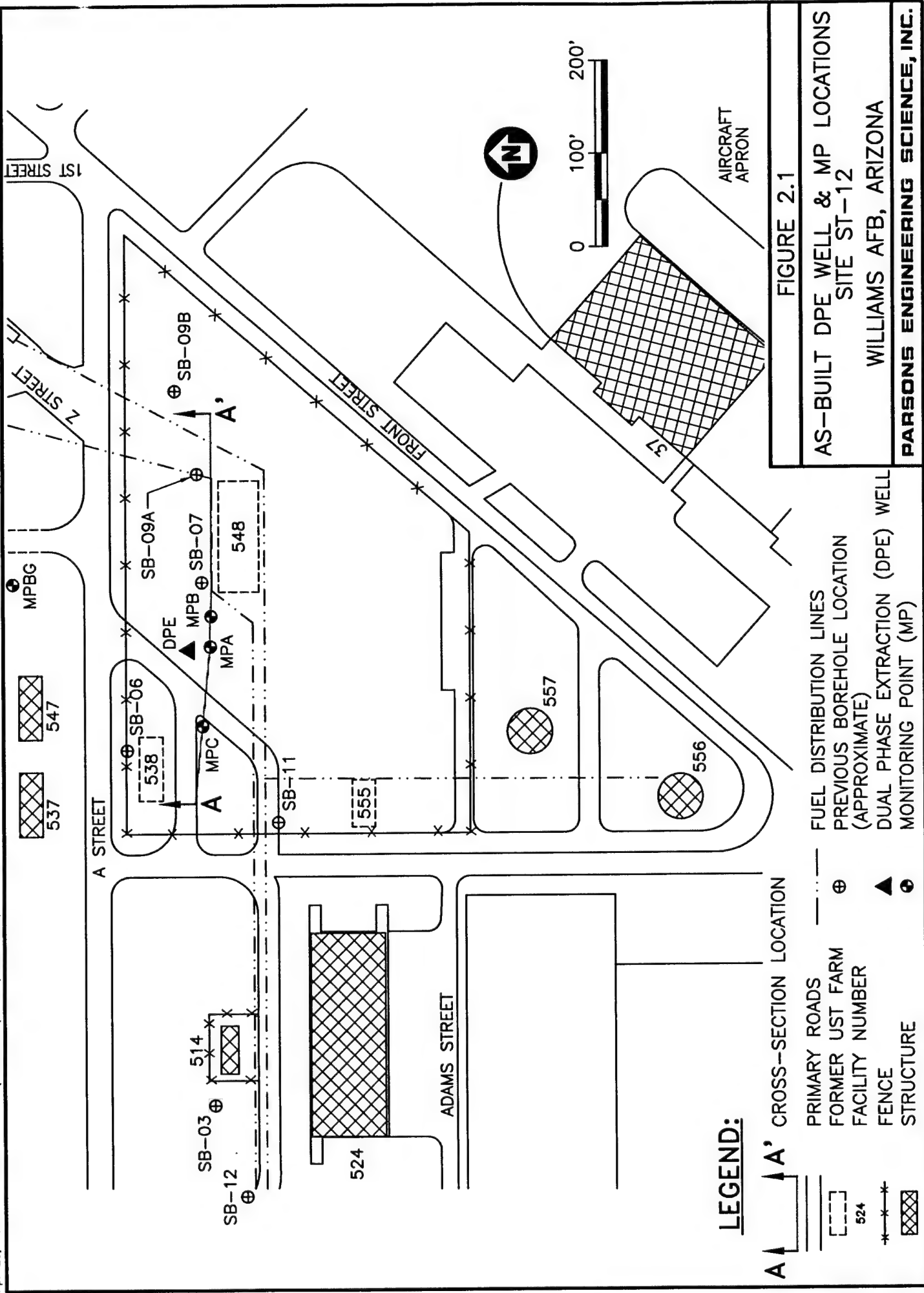
#### 2.1 DUAL-PHASE EXTRACTION WELL

The DPE well was installed by BEM in fuel-contaminated soils at the location shown on Figure 2.1. To allow use for air injection, vapor extraction, groundwater and product thickness monitoring, and product recovery using the same well, the DPE well was constructed as shown on Figures 2.2 and 2.3. The DPE well was constructed using three casings and screened sections, with each screen being positioned at a different depth interval. The shallow and mid-depth casings were composed of 1.5-inch-diameter Schedule 40 polyvinyl chloride (PVC) pipe, with 0.04-inch slotted PVC screens. The deep casing was composed of 4-inch-diameter Schedule 40 PVC pipe and 0.02-inch stainless steel screen. The annular spaces between the borehole wall and the screened intervals were filled with silica sand; the sand pack at the shallow and mid-depth screened intervals was composed of 4-12 silica sand and the sand pack around the deep screened interval was composed of 10-20 mesh sand. Two 5-foot thick bentonite layers were placed at 85 and 145 feet bgs to separate the screened intervals to allow airflow adjustment with depth and to prevent the possibility of providing a conduit for contaminant migration to the water table through the sand pack intervals. To prevent preferential flow through a highly permeable cobble zone at 150 to 160 feet bgs, blank casing and a bentonite seal was installed in this interval (Figures 2.2 and 2.3). Construction details are summarized in Table 2.1.

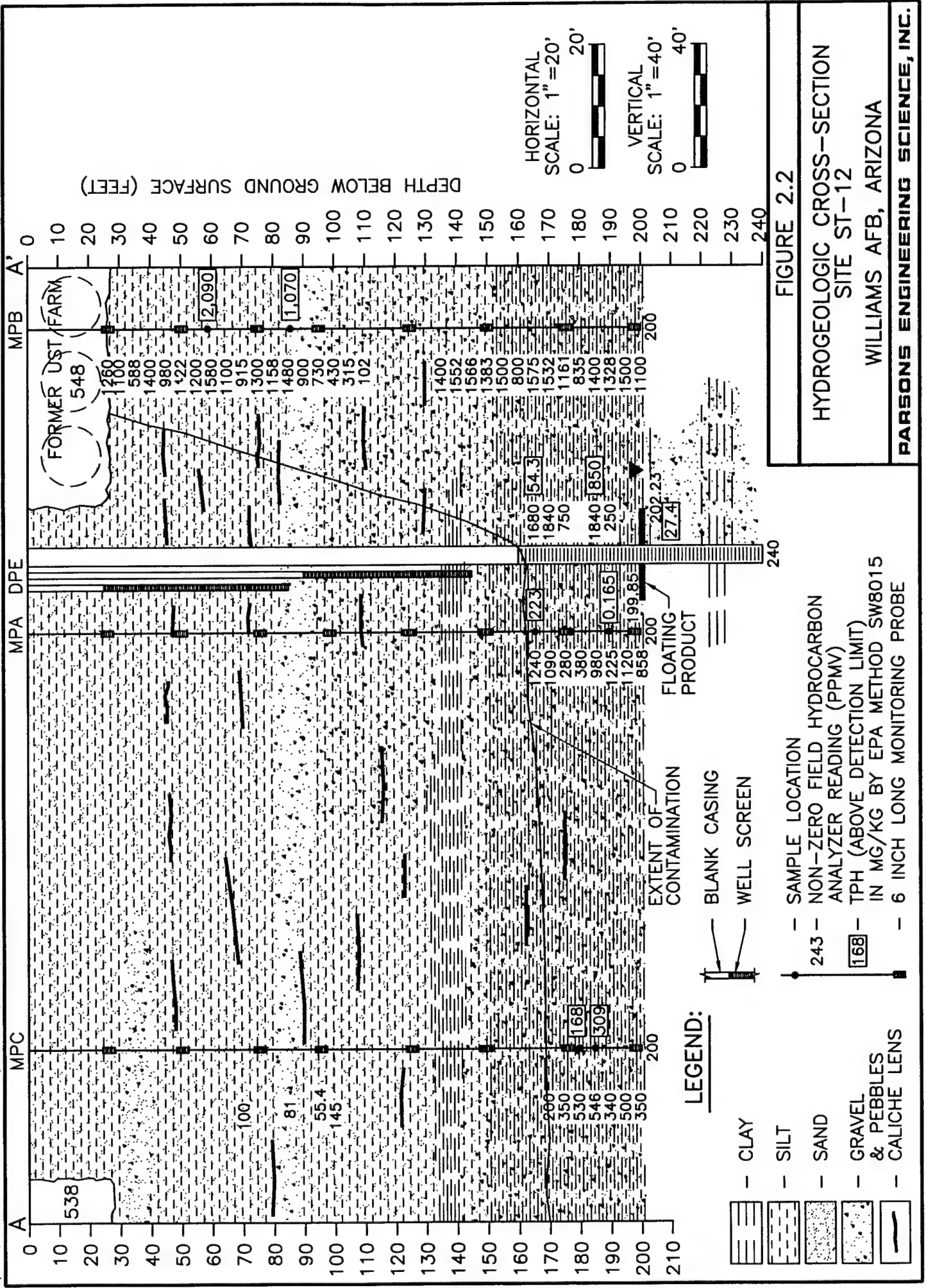
#### 2.2 MONITORING POINTS

Four multiple-depth MPs (MPA, MPB, MPC, and MPBG) were constructed as shown on Figure 2.4 at the locations shown on Figure 2.1. MPA, MPB, and MPC









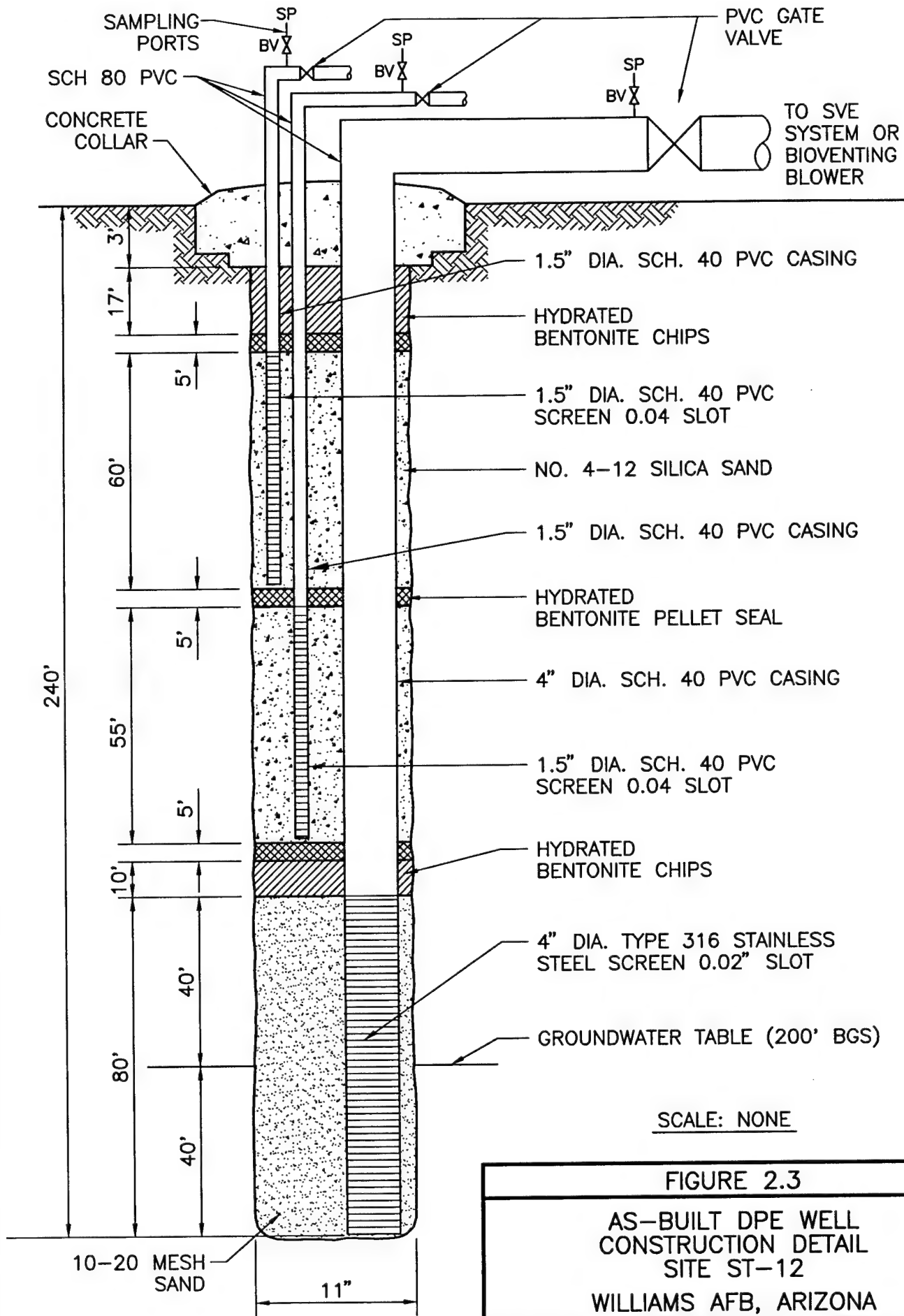


FIGURE 2.3

AS-BUILT DPE WELL  
CONSTRUCTION DETAIL  
SITE ST-12

WILLIAMS AFB, ARIZONA

PARSONS ENGINEERING SCIENCE, INC.

**Table 2.1**  
**DPE Well and Monitoring Point Construction Summary**  
**Site ST-12**  
**Williams AFB, Arizona**

Location	Total Borehole Depth (feet bgs) <sup>a/</sup>	Screened Intervals (feet bgs)
DPE Well <sup>b/</sup>	240	25-85, 90-145, 160-240
MPA <sup>c/</sup>	200	25, 50, 75, 95, 125, 150, 175, 200
MPB <sup>c/</sup>	200	25, 50, 75, 95, 125, 150, 175, 200
MPC <sup>c/</sup>	200	25, 50, 75, 95, 125, 150, 175, 200
MPBG <sup>b/</sup>	200	25, 50, 75, 95, 125, 150, 175, 200

<sup>a/</sup> bgs = below ground surface.

<sup>b/</sup> Installed by BEM in August and September 1996.

<sup>c/</sup> Installed by Parsons ES in September and early October 1996.

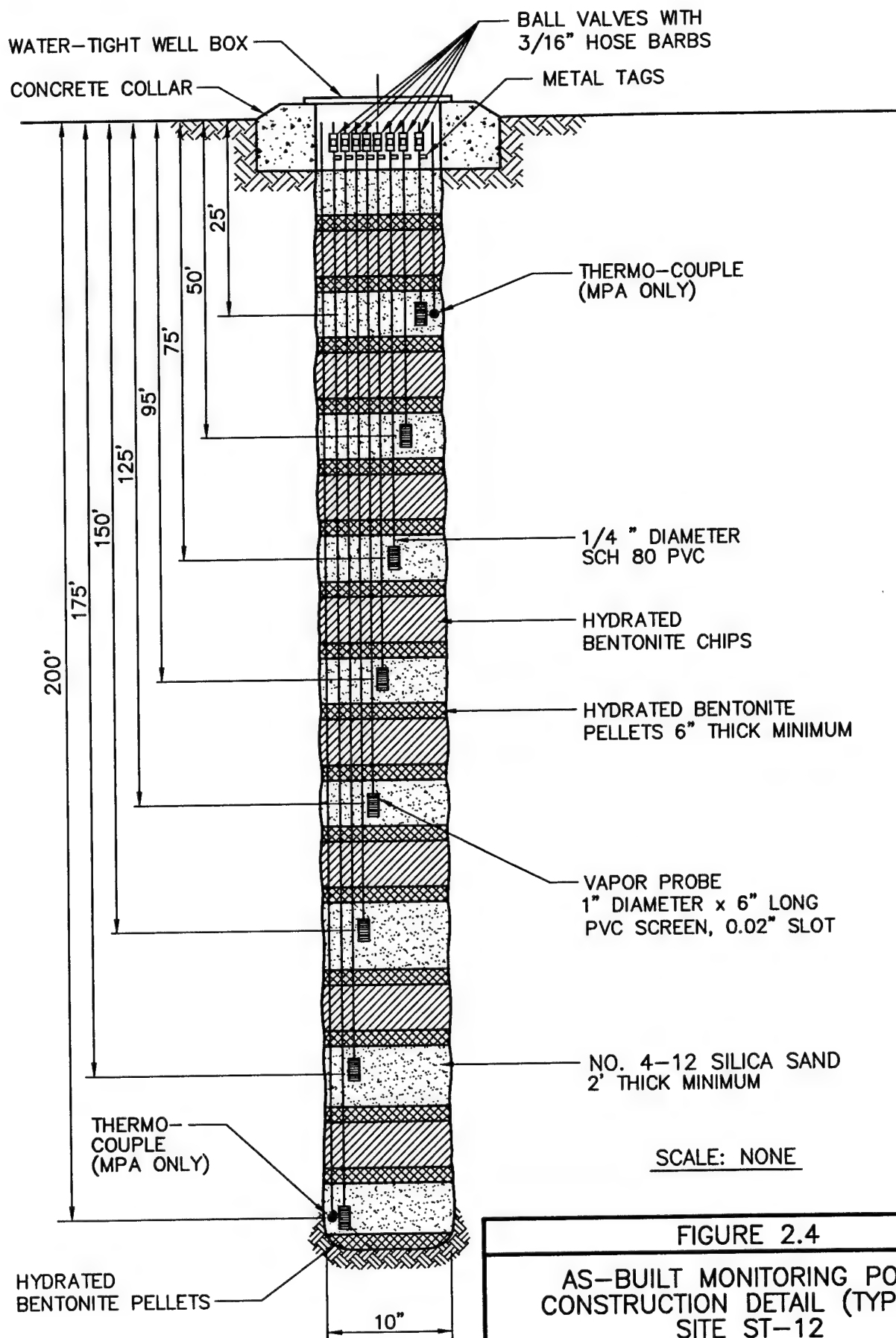


FIGURE 2.4

AS-BUILT MONITORING POINT  
CONSTRUCTION DETAIL (TYPICAL)  
SITE ST-12

WILLIAMS AFB, ARIZONA

PARSONS ENGINEERING SCIENCE, INC.

were constructed by Parsons ES. The background MP, MPBG, was installed by BEM. The MP screens were installed at the eight depth intervals listed on Table 2.1. MPA, MPB, and MPC were installed in areas of suspected soil contamination west of Facility 548. MPBG was installed approximately 240 feet north of the site in an area of uncontaminated soil. Each MP was constructed using 6-inch sections of 1-inch-diameter PVC well screen with 0.25-inch-diameter PVC riser pipes extending to the ground surface. Screened intervals were sand-packed and segregated using bentonite seals. At the top of each riser, a ball valve and a 3/16-inch hose barb were installed. The top of each MP was completed with a flush-mounted metal well protector set in a concrete pad. Thermocouples were installed at 25 and 200 feet bgs at MPA to measure the soil temperature profile at the site.

### **2.3 BLOWER UNIT**

A 2-horsepower Gast<sup>®</sup> regenerative blower unit was used at Site ST-12 for the bioventing pilot test. The blower was energized by 120-volt, single-phase, 30-amp line power from a distribution panel located on a power pole at the site. The pilot test blower was configured to inject air at 26 standard cubic feet per minute (scfm) into the two 1.5-inch-diameter screened intervals, and at 22 scfm into the 4-inch-diameter interval for about 5.5 hours during the air permeability test. After completion of the air permeability test, injection rates were increased to 59 scfm into the shallow and mid-depth screened intervals of the DPE well and to 33 scfm into the deep screened interval to provide sufficient oxygen to the subsurface so that an area-style respiration test could be conducted. After 20 hours of air injection, the respiration test began, and the blower unit was disconnected and removed from the site.

## SECTION 3

### SOIL AND SOIL GAS SAMPLING RESULTS

#### 3.1 SOIL SAMPLING RESULTS

During previous site investigations conducted in late 1993 and early 1994, soil contaminated with aviation gasoline (AVGAS) and JP-4 jet fuel was detected from approximately 25 feet bgs to the groundwater surface, which was encountered at 212 feet bgs (IT Corporation, 1995). A cobble zone was encountered throughout the site, starting at a depth of approximately 140 feet bgs and ranging from approximately 5 to 40 feet in thickness. Due to the proposed drilling depth of 200 feet bgs at the MPs and the presence of the cobble zone, boreholes were drilled using a dual-wall percussion hammer rig rather than a hollow-stem auger drilling rig. During drilling, a pneumatic hammer was used to drive a dual-wall casing into the ground. The lead casing was equipped with a cutting bit. Air was injected between the casing walls at a flow rate of approximately 400 scfm, and exited from ports in the bit. The airflow carried formation cuttings up through the center of the inner casing to the ground surface. This drilling method allows for rapid penetration of dense caliche and cobble zones.

Although the dual-wall percussion hammer drilling method has many advantages for drilling in deep soils containing cobbles, the primary disadvantage of its use is the quality of soil samples collected. A conventional split-barrel sampler attached to a slide hammer on a wire line is used for sample retrieval. During drilling at Site ST-12, cuttings often consisted of medium to coarse sand, gravel and pebbles, but split-barrel samples from the same depth were composed of silt, clayey silt and cobbles. Soil samples in the sampler shoe often contained voids, indicating that cuttings, rather than undisturbed formation, were being sampled. These observations suggested that the injected air was penetrating the formation in front of the bit and preferentially bringing the sands and gravels to the surface while leaving heavier silt and clay "clumps" and cobbles at the bottom of the hole to be sampled. Using dual-wall percussion hammer drilling, there is also the possibility that much of the volatile hydrocarbon contamination could have been volatilized by the injected air, which could have caused the field headspace readings and soil analytical results to be biased low.

Soils at the site consisted of silty sand and sandy silt to approximately 80 feet bgs. Two laterally extensive layers of cobbles, pebbles, gravel, and sand were encountered between 80 to 95, and 140 to 155 feet bgs (Figure 2.2). Silt, clay, sand, and cobble mixtures were encountered throughout the remaining depths. Thin lenses of hard, brittle caliche up to 2 to 4 inches thick were encountered starting from about 45 feet bgs and continuing to about 180 feet bgs (Figure 2.2). As previously described, the actual formation probably contained more medium to very coarse sand and gravel than

the soil samples indicated. Borehole logs prepared by Parsons ES for MPA, MPB, MPC, and by BEM for the DPE well and MPBG are included in Appendix B.

In the work plan (Appendix A), the DPE well location had been proposed near the previously-drilled borehole SB-07, located near the northwest corner of former underground storage tank (UST) facility 548. Borehole SB-07 had displayed the greatest vertical extent of contamination, with soil contamination starting at about 25 feet bgs and continuing to the groundwater table, measured at 212 feet bgs during that field effort. Unfortunately there was no field evidence of SB-07 (e.g., concrete cap, metal identification plate, etc.), or the location of the former UST facilities. Consequently, the DPE well was located as close to SB-07 as could be determined using site maps.

It appears that the source of contamination in the bioventing pilot testing area is near MPB (Figure 2.2). Field evidence of contamination was detected in soils at 25 feet bgs at MPB, and continued throughout most of the profile to the total depth of 200 feet bgs. With the exception of MPB, contamination was not as vertically extensive as anticipated. Field evidence of hydrocarbon contamination (e.g. odor, photoionization detector [PID] readings above background levels, staining) was not encountered until approximately 165 feet bgs in the DPE well, MPA, and MPC, indicating that a "smear zone" existed at these locations (i.e., the contamination spread horizontally when the product reached the groundwater surface). Depth to groundwater in the DPE well was measured at 202.23 feet bgs with 2.39 feet of free-phase product floating on the groundwater surface on 29 January 1997.

The DPE well and MPA are most likely located north and west of the former UST facility 548 location. MPC is most likely east of former UST facility 538, another possible contamination source. MPB appears to be located at the former UST facility 548, based on the pattern of contamination that was encountered.

Two soil samples with the highest field headspace TVH readings from MPA, MPB, and MPC were analyzed for total petroleum hydrocarbons (TPH) and benzene, toluene, ethylbenzene, and xylenes (BTEX) by US Environmental Protection Agency (USEPA) Method SW8015 modified for diesel-range organics and USEPA Method SW8020, respectively. Three samples from different depths were analyzed for soil moisture, pH, grain-size distribution, porosity, bulk density, alkalinity, total iron, total Kjeldahl nitrogen (TKN), and total phosphorus by American Society for Testing and Materials (ASTM) Method D2216, USEPA Method SW9045, ASTM Method D422, American Petroleum Institute (API) Method RP40, ASTM Method SM210B, and USEPA Methods E310.1M, SW6010, E351.2M, and E365.2, respectively. Soil samples were shipped via Federal Express<sup>®</sup> to InChcape Testing Services of Richardson, Texas for chemical and physical analysis. Field headspace TVH results and laboratory analytical results for TPH are shown on Figure 2.2. Laboratory analytical results for samples collected by Parsons ES are presented in Table 3.1. Laboratory analytical results and chain-of-custody forms are included as Appendix C. Laboratory analytical results collected by BEM are not included in this report.



**Table 3.1**  
**Soil Laboratory Analytical Results**  
**Site ST-12**  
**Williams AFB, Arizona**

Analyte (Units) <sup>a/</sup>	Sample Location - Depth (feet below ground surface)											
	MPA-100	MPA-165	MPA-175	MPA-190	MPB-60	MPB-65	MPB-85	MPB-105	MPC-175	MPC-180	MPC-185	
<u>Soil Hydrocarbons</u>												
TPH <sup>b/</sup> (mg/kg)	-- <sup>c/</sup>	223	--	0.165	2,090	--	1070	--	--	168	309	
Benzene (mg/kg)	--	0.764	--	3.66	5.8	--	11.5	--	--	0.24	0.67	
Toluene (mg/kg)	--	4.44	--	24.3	72.6	--	66.6	--	--	3.24	0.894	
Ethylbenzene (mg/kg)	--	2.9	--	15.3	48.7	--	32.9	--	--	2.75	1.04	
Xylenes (mg/kg)	--	9.85	--	35.1	172	--	110	--	--	15.6	4.45	
<u>Soil Inorganics</u>												
Iron (mg/kg)	11,400	--	--	--	--	8,440	--	--	13,500	--	--	
Alkalinity (mg/kg as CaCO <sub>3</sub> ) <sup>d/</sup>	250	--	--	--	--	150	--	--	200	--	--	
pH (units)	8.3	--	--	--	--	7.3	--	--	8.6	--	--	
TKN <sup>e/</sup> (mg/kg)	70	--	--	--	--	504	--	--	126	--	--	
Phosphates (mg/kg)	701	--	--	--	--	296	--	--	321	--	--	
<u>Soil Physical Parameters</u>												
Moisture (percent)	15.2	--	--	20.2	12.3	21.1	17.9	--	18.2	12.7	13.1	
Gravel (percent)	--	--	<0.1	--	--	<0.1	--	<0.1	--	--	--	
Sand (percent)	--	--	47.5	--	--	33.6	--	7.8	--	--	--	
Silt (percent)	--	--	35.5	--	--	49.4	--	76.2	--	--	--	
Clay (percent)	--	--	17	--	--	17	--	16.1	--	--	--	

<sup>a/</sup> mg/kg = milligrams per kilogram.

<sup>b/</sup> TPH = total petroleum hydrocarbons analyzed using USEPA Method SW8015 modified for diesel-range organics.

<sup>c/</sup> -- = not analyzed.

<sup>d/</sup> CaCO<sub>3</sub> = calcium carbonate.

<sup>e/</sup> TKN = total kjeldahl nitrogen.



### 3.2 SOIL GAS SAMPLING RESULTS

Six soil gas samples for laboratory analyses were collected from selected MP intervals on 3 October 1996, after completion of the drilling effort and prior to startup of the BEM SVE pilot test using the thermal oxidation treatment unit. Generally, samples with the lowest oxygen and highest TVH concentrations, as determined by field screening, were selected for analysis. All soil gas samples were collected following procedures in the AFCEE bioventing protocol document (Hinchee *et al.*, 1992). The soil gas samples were collected using a 1-scfm pump and a vacuum chamber fitted with a new Tedlar<sup>®</sup> bag for each sample. The samples were transferred from the Tedlar<sup>®</sup> bags to laboratory-provided, evacuated, 1-liter SUMMA<sup>®</sup> canisters. Soil gas samples were shipped via Federal Express<sup>®</sup> to Air Toxics, Inc. in Folsom, California for TVH and BTEX analysis by USEPA Method TO-3. Laboratory and field screening results are provided in Table 3.2. Laboratory reports and chain-of-custody forms are included as Appendix C. The high oxygen levels may be caused by air injection that was performed during drilling. Laboratory TVH concentrations were extremely high, ranging from 42,000 to 290,000 ppmv. Higher TVH concentrations were observed at sampling locations immediately above the water table at 200 feet bgs, indicating the presence of free-phase product.

### 3.3 EXCEPTIONS TO THE WORK PLAN AND PROTOCOL DOCUMENT PROCEDURES

The bioventing pilot test was performed according to the work plan (see Appendix A), and using procedures described in the protocol document (Hinchee *et al.*, 1992). Exceptions to the work plan and the protocol document are listed in the following subsections.

#### 3.3.1 Exceptions to the Bioventing Protocol Document Procedures

- A nested DPE well was constructed instead of a conventional air injection vent well.
- Additional soil and soil gas samples were collected and analyzed to better define the extent of contamination.
- Because an area-wide respiration test was conducted, helium was not used as a tracer during the respiration test.

#### 3.3.2 Exceptions to the Pilot Test Work Plan

- Locations of the boreholes changed slightly from those proposed in the work plan. Because there was no field evidence of the SB-07 location (e.g., concrete cap, metal identification plate, etc.) or the former UST facilities, the DPE well was located as close to SB-07 as could be determined using site maps.
- Soil samples were analyzed for TPH by USEPA Method SW8015 modified for diesel-range organics rather than jet fuel.

**Table 3.2**  
**Initial Soil Gas Field and Laboratory Analytical Results**  
**3 October 1996**  
**Site ST-12**  
**Williams AFB, Arizona**

Sample Location	Depth (feet bgs) <sup>a/</sup>	Field Measurements				Laboratory Analytical Results (ppmv)				
		Oxygen (%)	Carbon Dioxide (%)	TVH (ppmv) <sup>b/</sup>	Temperature (°F)	TVH	Benzene	Toluene	Ethylbenzene	Xylenes
MPA	25	13.0	4.5	140	79.8	-- <sup>c/</sup>	--	--	--	--
	50	9.5	5.3	520	--	--	--	--	--	--
	75	11.2	5.8	9,600	--	--	--	--	--	--
	95	8.0	7.5	> 20,000	--	42,000	430	430	33	71
	125	3.2	9.4	> 20,000	--	120,000	1,000	1,000	70	210
	150	15.0	3.8	> 20,000	--	--	--	--	--	--
	175	17.8	1.3	> 20,000	--	--	--	--	--	--
	200	10.5	0.5	> 20,000	79.0	--	--	--	--	--
MPB	25	0.0	2.6	4,400	--	--	--	--	--	--
	50	3.0	3.0	11,600	--	--	--	--	--	--
	75	17.0	2.6	20,000	--	54,000	440	580	77	220
	95	17.5	2.0	> 20,000	--	--	--	--	--	--
	125	11.5	5.0	20,000	--	--	--	--	--	--
	150	17.0	2.5	18,000	--	--	--	--	--	--
	175	18.5	0.5	> 20,000	--	--	--	--	--	--
	200	10.6	0.8	> 20,000	--	140,000	600	600	70	160
MPC	25	10.0	4.5	100	--	--	--	--	--	--
	50	5.0	8.0	460	--	--	--	--	--	--
	75	2.5	5.0	10,000	--	--	--	--	--	--
	95	5.0	9.0	19,500	--	--	--	--	--	--
	125	3.0	10.0	> 20,000	--	97,000	730	890	60	180
	150	6.0	6.5	> 20,000	--	--	--	--	--	--
	175	9.0	2.3	> 20,000	--	--	--	--	--	--
	200	3.5	1.2	> 20,000	--	290,000	1,500	2,000	180	460
MPBG	25	18.0	1.8	120	--	--	--	--	--	--
	50	15.2	3.8	140	--	--	--	--	--	--
	75	13.2	5.0	140	--	--	--	--	--	--
	95	3.0	9.5	3,800	--	--	--	--	--	--
	125	4.8	8.3	> 20,000	--	--	--	--	--	--
	150	8.2	4.2	> 20,000	--	--	--	--	--	--
	175	6.1	2.5	> 20,000	--	--	--	--	--	--
	200	5.4	1.5	> 20,000	--	--	--	--	--	--
DPE Well	shallow	3.5	10.0	3,400	--	--	--	--	--	--
	middle	4.0	10.0	9,400	--	--	--	--	--	--
	deep	15.8	2.0	> 20,000	--	--	--	--	--	--

<sup>a/</sup> bgs = below ground surface.

<sup>b/</sup> total volatile hydrocarbons in parts per million by volume.

<sup>c/</sup> -- data was not collected.

- A blower system was not installed at Site ST-12 for a one-year extended bioventing test. Instead, an ICE/SVE system was installed at the DPE well.
- The work plan stated that an area-style respiration test would be performed after the completion of the SVE/thermal oxidation pilot test by BEM. However, the SVE pilot test did not provide sufficient levels of oxygen to the subsurface to perform a respiration test. Therefore, an area-wide respiration test was conducted after the air permeability test was completed.

## SECTION 4

### BIOVENTING PILOT TEST RESULTS

#### 4.1 INITIAL SOIL GAS CHEMISTRY

On 4 December 1996, one day after completion of the SVE pilot test by BEM, and prior to initiating any air injection, soil gas samples again were collected from the MPs and analyzed for initial oxygen, carbon dioxide, and TVH concentrations using portable gas analyzers, as described in the technical protocol document (Hinchee *et al.*, 1992). Table 4.1 summarizes the initial soil gas chemistry. To remove stagnant gas prior to collecting the soil gas samples, the MPs were purged until oxygen levels had stabilized.

In the pilot testing area (i.e., at MPA, MPB, and MPC), sampling locations exhibited soil gas oxygen concentrations at or below 4 percent, with the exceptions of MPA-25, MPA-175, MPB-175, and MPC-25, strongly indicating that biological fuel degradation has depleted subsurface oxygen. The high oxygen concentrations at the 25-foot depths reflect the fact that remediation of near-surface soils has already been completed. At the 175-foot depths, it appears that a thin, highly permeable zone of soil exists and has been oxygenated by soil gas extraction from the DPE well during the SVE/thermal oxidation pilot test. Carbon dioxide, a by-product of aerobic fuel biodegradation, was also observed at concentrations as high as 16 percent, providing further evidence of aerobic hydrocarbon biodegradation. TVH concentrations exceeded 20,000 ppmv at and below 95, 50, and 75 feet bgs at MPA, MPB, and MPC, respectively.

Although MPBG was located over 240 feet north of the site in an area thought to be uncontaminated, sampling results indicated that soil gas below approximately 90 feet bgs at MPBG is impacted by fuel hydrocarbons, and that aerobic biodegradation of hydrocarbon vapors is occurring (Table 4.1). Oxygen concentrations at MPBG screens below 90 feet bgs ranged from anaerobic levels to a maximum concentration of 2 percent, and TVH concentrations ranged from 5,200 ppmv to greater than 20,000 ppmv. Carbon dioxide concentrations were also elevated, ranging from 2.6 to 15.0 percent at depths greater than 90 feet bgs. Volatile hydrocarbon contamination at MPBG could be from an unidentified former source near the north side of Site ST-12. It is also possible that volatile contamination may have diffused from the source near MPB.

#### 4.2 AIR PERMEABILITY

An air permeability test was conducted according to protocol document procedures by injecting air into the DPE well and monitoring changes in pressure and soil gas

**Table 4.1**  
**Initial Soil Gas Chemistry**  
**4 December 1996**  
**Site ST-12**  
**Williams AFB, Arizona**

Sample Location	Depth (feet bgs)	Oxygen (%)	Carbon Dioxide (%)	TVH - Field (ppmv) <sup>a/</sup>
MPA	25	20.0	2.9	84
	50	3.5	14.5	620
	75	1.5	15.8	8,600
	95	1.0	15.0	>20,000
	125	3.0	11.0	>20,000
	150	0.0	10.9	>20,000
	175	16.5	2.6	>20,000
	200	-- <sup>b/</sup>	--	--
MPB	25	3.0	9.5	8,000
	50	0.5	12.5	>20,000
	75	1.0	16.0	>20,000
	95	0.0	16.0	>20,000
	125	0.5	15.0	>20,000
	150	1.0	10.5	>20,000
	175	20.8	0.6	>20,000
	200	4.0	2.5	>20,000
MPC	25	17.0	4.5	166
	50	0.0	12.8	5,200
	75	0.0	14.0	>20,000
	95	3.1	11.0	>20,000
	125	0.0	15.0	>20,000
	150	0.0	12.2	>20,000
	175	0.0	5.0	>20,000
	200	--	--	--
MPBG	25	19.0	3.0	152
	50	16.0	4.5	120
	75	13.5	6.5	180
	95	1.8	14.0	5,200
	125	0.0	15.0	>20,000
	150	0.0	11.0	>20,000
	175	0.0	9.3	>20,000
	200	2.0	2.6	>20,000

<sup>a/</sup> Total volatile hydrocarbon field screening result in parts per million (volume per volume).

<sup>b/</sup> Measurements were not possible due to screen plugging.

Note: Soil gas data were collected on 4 December 1996, one day after completion of the SVE pilot test by BEM using thermal oxidation.

parameters at the MPs. Air was injected for 5.5 hours into the shallow, mid-depth and deep screened intervals of the DPE well at a constant injection pressure of 8 inches of water and air flow rates of 26, 26, and 22 scfm, respectively. The maximum pressure response measured at each MP is listed in Table 4.2. The pressure measured at the MPs increased steadily during the first 20 to 30 minutes of the test, and continued increasing at a slower rate for the remainder of the test. At MPC, located 77 feet from the DPE well, the maximum pressure responses ranged from 0.70 inches of water, measured at the 25-foot depth, to 3.05 inches of water, measured at the 175-foot depth. No significant pressure responses were observed at MPBG. Because pressure responses measured at the MPs continued to increase over the duration of the air permeability test, the dynamic method of determining air permeability was selected. Soil gas permeabilities ranged from approximately 9 to 34 darcys. This is higher than anticipated given the silty nature of the soil samples collected during the drilling effort. However, as previously mentioned, the drilling method could have caused a significant percentage of coarse-grained soils to be removed from the soil samples, and the actual percentage of coarse-grained material may be much higher than grain size analyses indicated. Because a radius of pressure influence of at least 77 feet was measured at all depths, it is anticipated that the long-term radius of oxygen influence at Site ST-12 would exceed 77 feet.

#### **4.3 OXYGEN INFLUENCE**

The depth and radius of oxygen increase in the subsurface resulting from air injection into the DPE well during pilot testing is the primary design parameter for full-scale bioventing system design. Table 4.3 presents the changes in soil gas oxygen levels that occurred during 24 hours of air injection into the DPE well. With the exception of the 50- and 125-foot screened depths, all depths at MPA showed significant increases in soil gas oxygen concentrations. At MPB, significant increases in soil gas oxygen concentrations were observed at the 95 and 150 foot depths. At MPC, only the 175-foot depth showed an increase in oxygen concentrations. However, because pressure responses were measured at all screened depths at MPC, it is likely that long-term air injection at the DPE well would cause soil gas oxygen concentrations to increase at all depths at MPC. Based on measured changes in oxygen levels, the radius of influence for a bioventing system at this site is at least 20 feet, and would likely exceed 77 feet based on the low oxygen utilization rates measured during the respiration test (Section 4.4) and the pressure response measured at all depths of MPC.

During the 24-hour air injection period, soil gas samples could not be collected from the MP screens at 200 feet bgs at MPA and MPC. This was due to saturated conditions near the water table, measured at approximately 202.23 feet bgs at the DPE well on 29 January 1997. The groundwater table at Site ST-12 is rising at a rate of up to 5 feet per year, and the 200-foot-deep MP screen at MPB is also expected to become submerged.

#### **4.4 *IN SITU* RESPIRATION RATES**

An area-style respiration test was conducted at all MP screens that displayed field evidence of fuel contamination (e.g., elevated TVH readings) and contained oxygen at concentrations of at least 5 percent following 24 hours of air injection at the DPE well.

**Table 4.2**  
**Maximum Pressure Response During the Air Permeability Test**  
**Site ST-12**  
**Williams AFB, Arizona**

**TEST PARAMETERS:**

Injection Well: DPE Well  
Injection Flow Rate: 26 standard cubic feet per minute (25-85 ft, 90-145 ft)  
22 standard cubic feet per minute (160-200 ft)

Location	Distance from DPE Well (feet)	Screen Depth (feet bgs) <sup>a/</sup>	Maximum Pressure Response (in. of water) <sup>b/</sup>
MPA	21	25	0.95
		50	1.45
		75	1.60
		95	2.50
		125	2.80
		150	1.85
		175	3.90
		200	3.40
MPB	40	25	1.10
		50	1.20
		75	1.50
		95	2.10
		125	2.25
		150	1.70
		175	3.20
		200	2.80
MPC	77	25	0.70
		50	1.00
		75	1.10
		95	1.30
		125	2.00
		150	1.80
		175	3.05
		200	2.60

<sup>a/</sup> bgs = below ground surface.

<sup>b/</sup> Data collected after 320 minutes of air injection at the DPE well.

**Table 4.3**  
**Influence of Air Injection at the DPE Well on Monitoring Point Oxygen Levels**  
**Site ST-12**  
**Williams AFB, Arizona**

Sample Location	Distance from DPE Well (feet)	Depth (feet bgs) <sup>a/</sup>	Initial O <sub>2</sub> <sup>b/</sup> (percent)	Interim O <sub>2</sub> <sup>c/</sup> (percent)	Final O <sub>2</sub> <sup>d/</sup> (percent)
MPA	21	25	20.0	19.2	20.5
		50	3.5	1.5	2.0
		75	1.5	0.0	18.3
		95	1.0	1.2	19.7
		125	3.0	0.0	0.5
		150	0.0	0.0	9.2
		175	16.5	19.8	20.0
		200	-- <sup>e/</sup>	--	--
MPB	40	25	3.0	0.0	3.2
		50	0.5	0.0	0.0
		75	1.0	0.0	0.5
		95	0.0	0.0	11.0
		125	0.5	0.0	0.0
		150	1.0	2.8	6.4
		175	20.8	20.5	20.4
		200	4.0	3.2	5.5
MPC	77	25	17.0	16.5	14.3
		50	0.0	0.2	0.0
		75	0.0	0.0	0.0
		95	3.1	2.0	2.0
		125	0.0	0.0	0.0
		150	0.0	0.0	0.0
		175	0.0	0.0	13.8
		200	--	--	--

<sup>a/</sup> bgs = below ground surface.

<sup>b/</sup> one day after completion of the SVE pilot test by BEM using thermal oxidation.

<sup>c/</sup> data collected after four hours of air injection into the DPE well at 74 scfm.

<sup>d/</sup> data collected after 20 additional hours of air injection into the DPE well at 170 scfm.

<sup>e/</sup> -- Measurements were not possible due to screen plugging.



Following the injection period, oxygen losses and increases in TVH and carbon dioxide concentrations were measured at these selected MP screens for a period of 25 days. The measured oxygen losses were then used to calculate petroleum hydrocarbon biodegradation rates. The results of the *in situ* respiration testing are presented on Figures 4.1 through 4.8. Table 4.4 provides a summary of the observed oxygen utilization rates and the calculated fuel biodegradation rates.

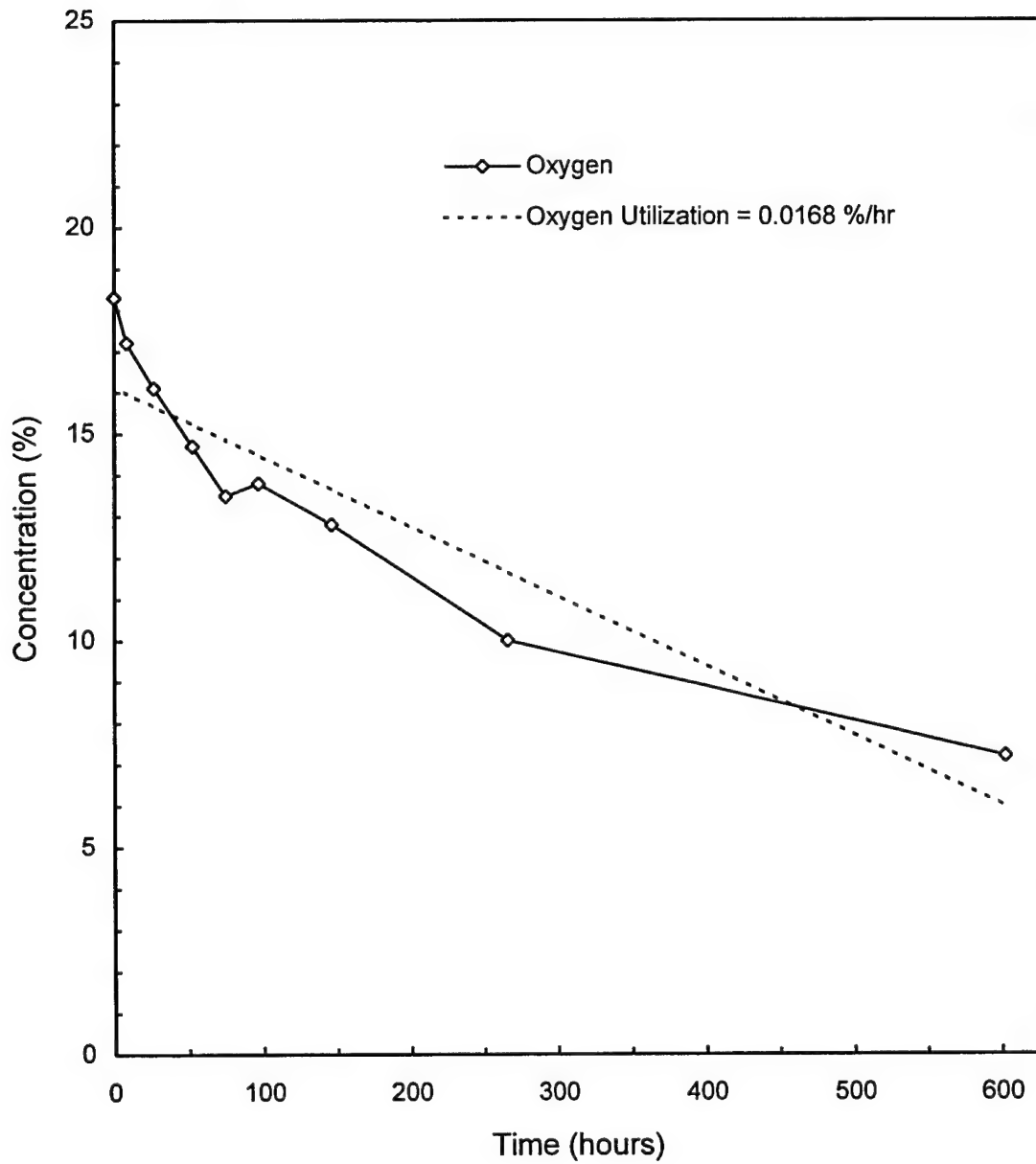
Oxygen losses measured at the MPs occurred at low rates, ranging from 0.0040 percent per hour at MPB-175 to 0.12 percent per hour at MPB-25. These rates are typical of desert sites in the southwestern U.S., and are similar to rates observed at Site FT-02, a former fire training area at Williams AFB (BEM, 1997). Generally, oxygen utilization rates were found to be higher at shallower depths. The highest oxygen utilization rate observed during this respiration test was at MPB at a depth of 25 feet bgs, where oxygen was consumed at a rate of 0.12 percent per hour. In comparison, rates observed at depths between 75 and 175 feet bgs ranged from 0.0040 to 0.017 percent per hour, with the exception of MPB-150 where an oxygen utilization rate of 0.079 percent per hour was observed.

Based on the oxygen utilization rates observed during the respiration tests at Site ST-12, an estimated 10 to 760 mg of fuel per kg of soil can be degraded each year at this site. At depths of 75 to 175 feet bgs (excluding the test results at MPB-150), estimated biodegradation rates ranged from only 10 to 100 mg/kg/yr. This conservative estimate is based on an average air-filled porosity of approximately 0.11 liter of air per kg of soil, and a ratio of 3.5 mg of oxygen consumed for every 1 mg of fuel biodegraded. Actual fuel biodegradation rates may vary from these estimates.

#### 4.5 AIR EMISSIONS MONITORING

Air quality monitoring was conducted in the breathing zone and at the DPE well and MP wellheads using a PID to determine if air injection at the DPE well would displace volatile organic compounds (VOCs) into the atmosphere at unacceptable levels. Readings were collected every 15 minutes for the first hour of the air permeability test, when air was being injected into DPE well at a total flow rate of 74 scfm. No VOC readings were detected above background levels during the air quality monitoring period. The potential for air emissions at this site is relatively low, in part due to the depth of the most contaminated soil intervals. Emissions should be minimal because accumulated vapors will move horizontally outward from the DPE well screens, given the layered stratigraphy at the site. Some hydrocarbon vapors could be biodegraded as they move horizontally through the soil. Also, in most areas at Site ST-12, the minimum depth to contamination is 25 feet bgs. This is due to the sources of site contamination being large-capacity USTs, and to the successful remediation of the top 25 feet of soil using SVE in a previous remediation effort throughout the western side of the site.

**Figure 4.1**  
**Respiration Test Results at MPA-75**  
**Site ST-12**  
**Williams AFB, Arizona**



**Figure 4.2**  
**Respiration Test Results at MPA-95**  
**Site ST-12**  
**Williams AFB, Arizona**

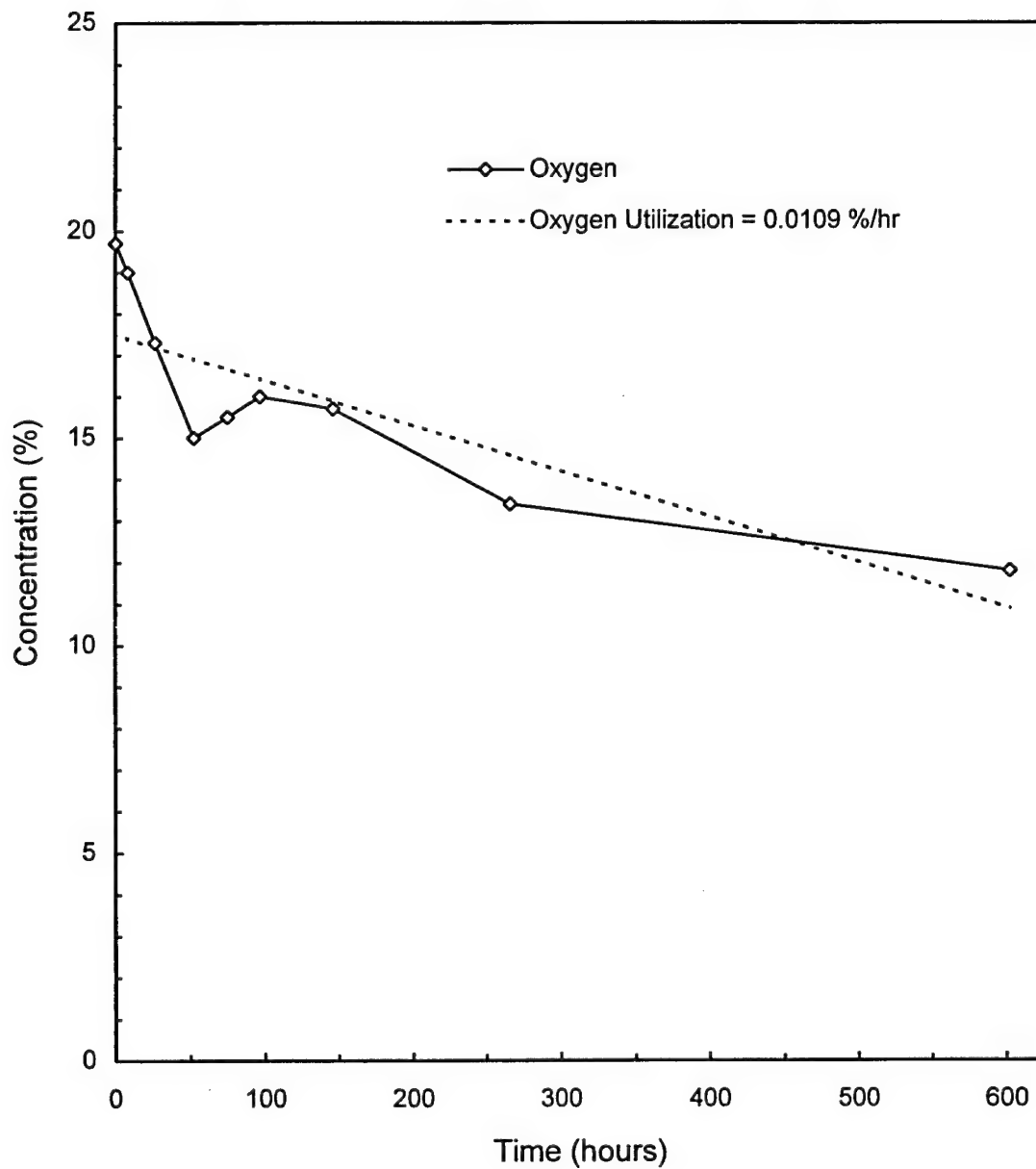
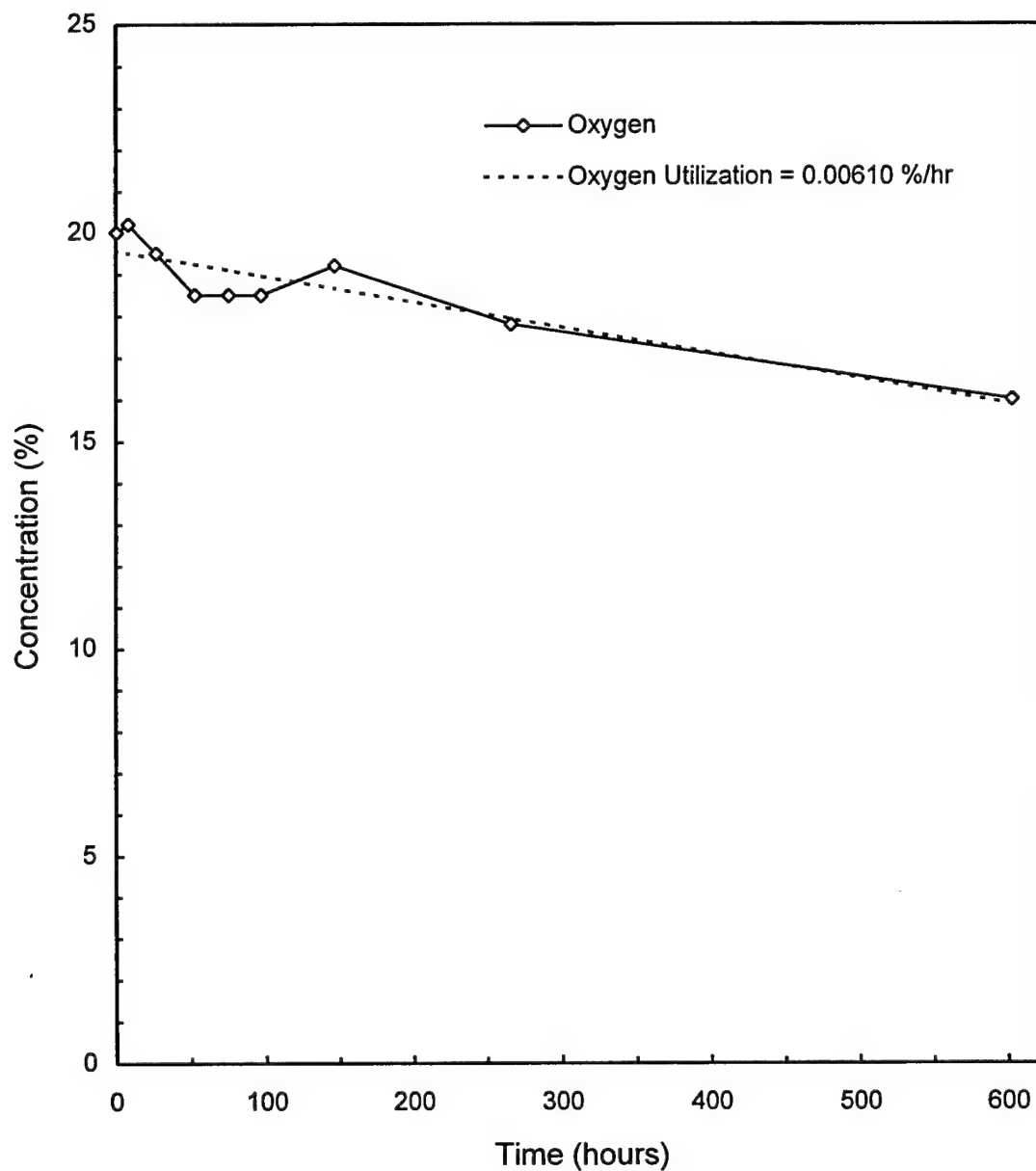
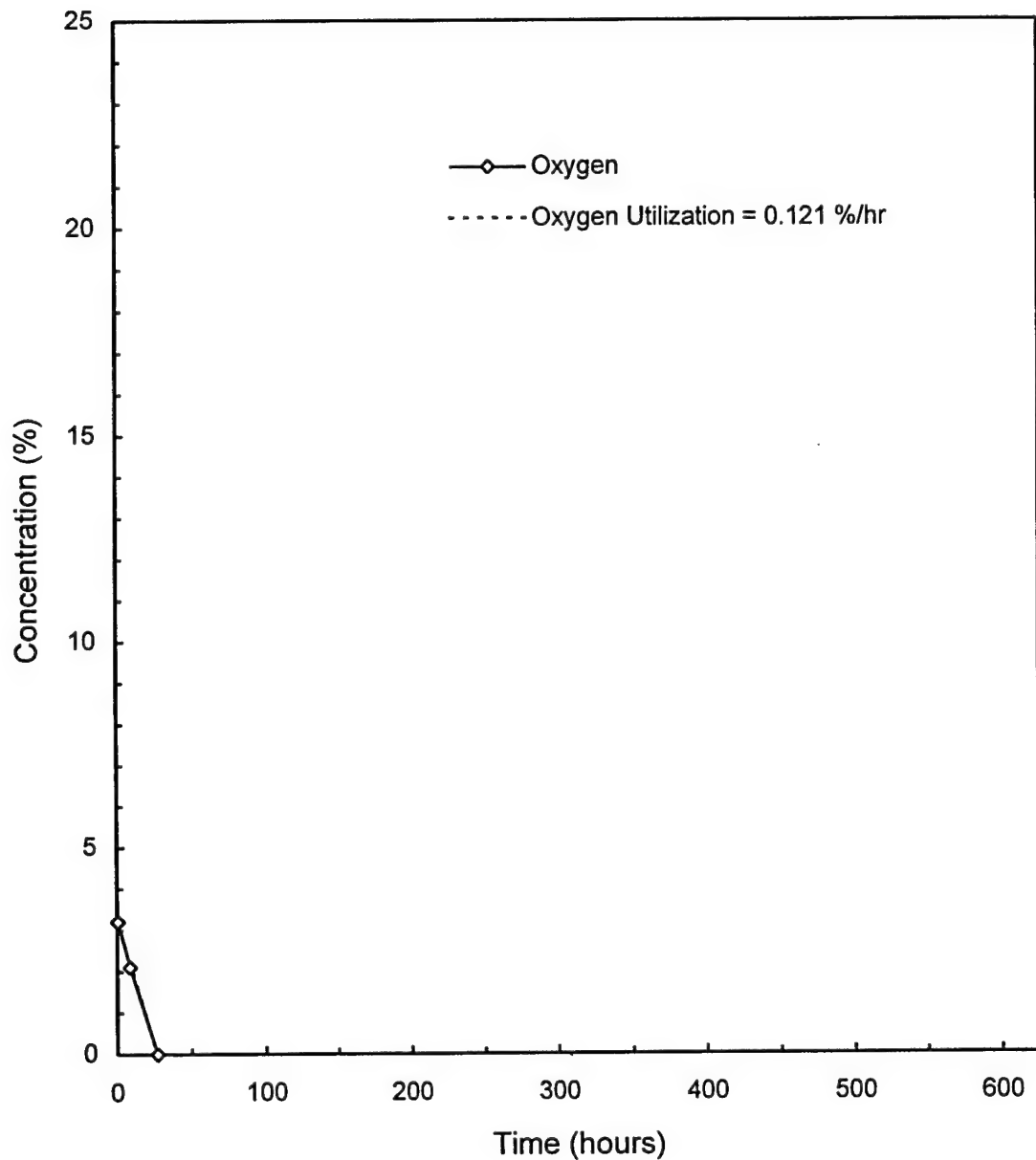


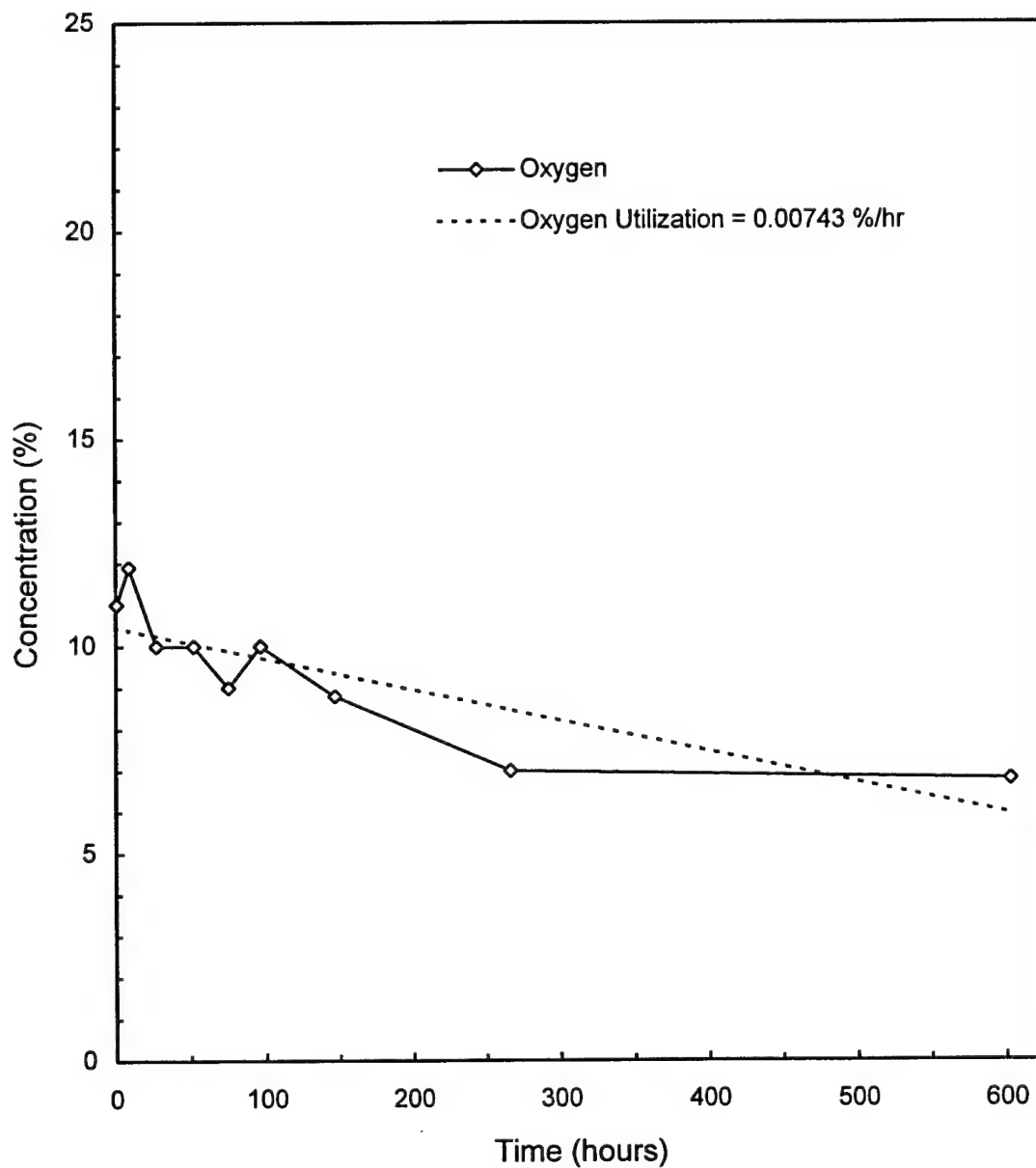
Figure 4.3  
Respiration Test Results at MPA-175  
Site ST-12  
Williams AFB, Arizona



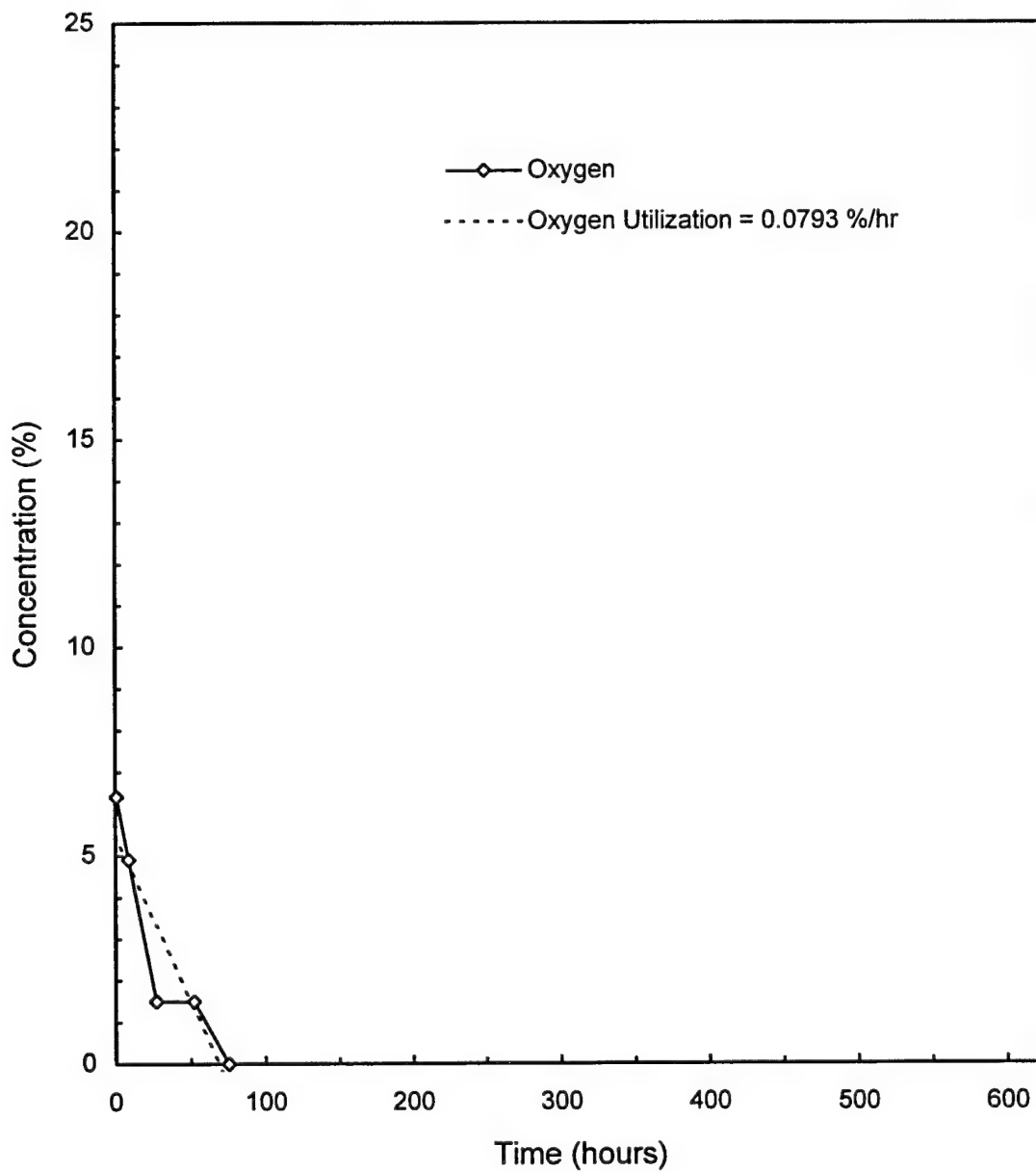
**Figure 4.4**  
**Respiration Test Results at MPB-25**  
**Site ST-12**  
**Williams AFB, Arizona**



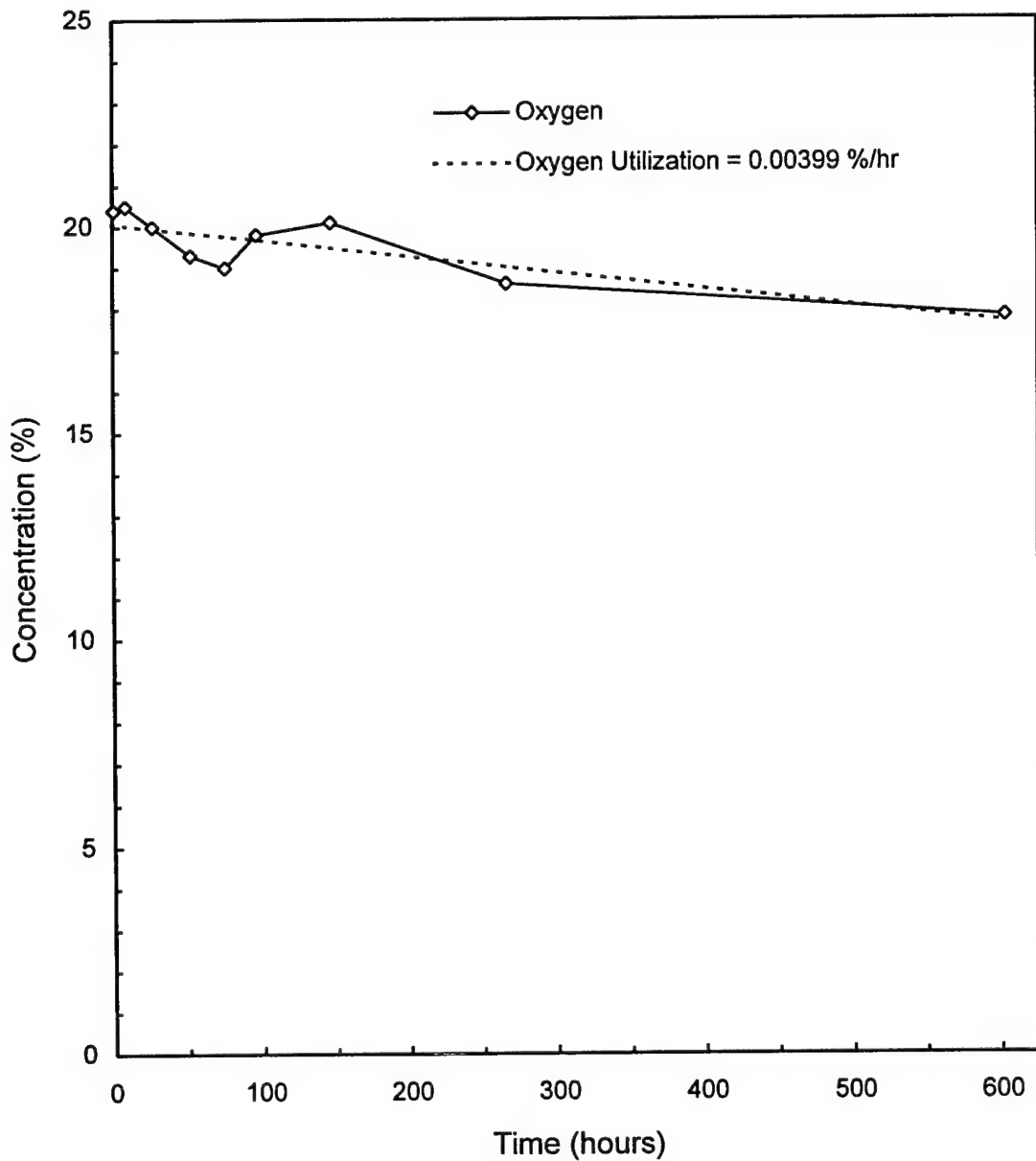
**Figure 4.5**  
**Respiration Test Results at MPB-95**  
**Site ST-12**  
**Williams AFB, Arizona**



**Figure 4.6**  
**Respiration Test Results at MPB-150**  
**Site ST-12**  
**Williams AFB, Arizona**

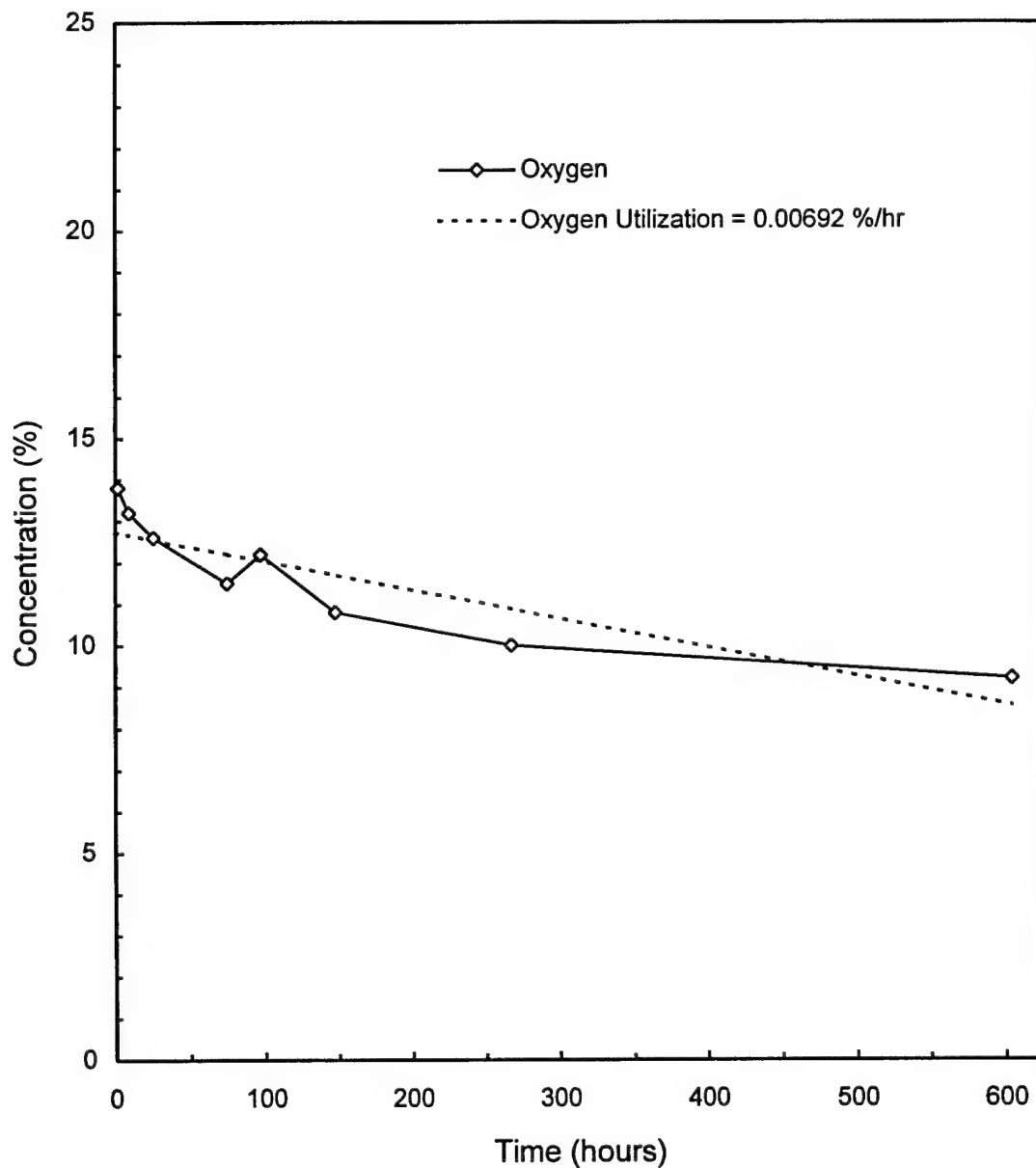


**Figure 4.7**  
**Respiration Test Results at MPB-175**  
**Site ST-12**  
**Williams AFB, Arizona**





**Figure 4.8**  
**Respiration Test Results at MPC-175**  
**Site ST-12**  
**Williams AFB, Arizona**



**Table 4.4**  
**Respiration Test Results**  
**Site ST-12**  
**Williams AFB, Arizona**

Sample Location	Depth (feet)	Oxygen Utilization Rate (%/hr)	Hydrocarbon Biodegradation Rate (mg/kg/year)
MPA	25	a/	a/
	50	b/	b/
	75	0.0168	100
	95	0.0109	40
	125	b/	b/
	150	c/	c/
	175	0.00610	20
	200	d/	d/
MPB	25	0.121	760
	50	b/	b/
	75	b/	b/
	95	0.00743	20
	125	b/	b/
	150	0.0793	210
	175	0.00399	10
	200	c/	c/
MPC	25	a/	a/
	50	b/	b/
	75	b/	b/
	95	b/	b/
	125	b/	b/
	150	b/	b/
	175	0.00692	20
	200	d/	d/

a/ Not tested due to low field TVH readings.

b/ Not enough oxygen was present to run the respiration test.

c/ Oxygen concentrations increased or remained relatively constant during test.

d/ Measurements were not possible due to screen plugging.

## SECTION 5

### RECOMMENDATIONS

The bioventing pilot test performed at Site ST-12 indicated that oxygen had been depleted in contaminated vadose zone soils, and that air injection is an effective method of increasing oxygen concentrations in these soils. Results of initial soil gas sampling indicated that oxygen was depleted and carbon dioxide concentrations were elevated in contaminated soil gas. Soil gas sampling results also indicated that TVH concentrations were extremely high at Site ST-12, ranging from 42,000 to 290,000 ppmv in laboratory TVH analyses (Table 3.2). Results of the air permeability/oxygen influence test indicate that the radius of oxygen influence exceeds 20 feet at most depths, and exceeds 77 feet in the more permeable formations (Table 4.3). Because significant pressure response was measured at all screened depths at MPC (Table 4.2), it is expected that a radius of oxygen influence of over 77 feet would be achieved by implementing long-term air injection at the DPE well.

However, respiration tests indicated that petroleum hydrocarbon biodegradation rates at Site ST-12 were relatively low, ranging from 10 to 760 mg of fuel per kg of soil per year across the site, and ranging from 10 to 100 mg of fuel per kg of soil per year at depths between 75 and 175 feet bgs (except at MPB-150, where a fuel biodegradation rate of 210 mg of fuel per kg of soil per year was calculated). These low biodegradation rates are typical of desert sites in the southwestern U.S. Biodegradation rates have been observed to increase over extended periods of air injection bioventing at many sites. However, in a 1-year-long bioventing pilot test recently completed by Parsons ES under subcontract to BEM at Site FT-02 at Williams AFB (BEM, 1997), petroleum hydrocarbon biodegradation rates did not increase over time. Conditions at Site FT-02 are very similar to those at Site ST-12, and therefore it is not expected that biodegradation rates will increase over time at Site ST-12.

Because contaminated soil zones are highly permeable, TVH concentrations are extremely high, and fuel biodegradation rates are extremely low, it was determined that SVE would be more cost effective than bioventing for vadose zone remediation at Site ST-12. A VR Systems, Inc. Model V4 ICE unit was started at Site ST-12 in February 1997, and was found to be capable of removing volatile hydrocarbons from the subsurface through the DPE well and destroying them at a rate of over 480 gallons per day. Because this treatment scheme is successful in targeting fuel residuals in the vadose zone, and in addressing volatile free product found on the groundwater table, long-term use of SVE/ICE is planned. A second Model V4 ICE unit was moved to the site in April 1997, and both ICE units are currently extracting vapor from the DPE well.

Based on the results of the bioventing pilot test and the SVE pilot tests conducted at the site, full-scale vapor extraction and treatment using two Model V4 ICE units has been selected for treatment of the vadose zone and free-phase product. No further application of bioventing is planned for the site.

## SECTION 6

### REFERENCES

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**APPENDIX A**

**BIOVENTING PILOT TEST WORK PLAN**

**Bioventing Pilot Test Work Plan  
Liquid Fuel Storage Area, ST-12**



**Williams Air Force Base  
Arizona**

**Prepared For**

**Air Force Center for Environmental Excellence  
Technology Transfer Division  
Brooks Air Force Base  
San Antonio, Texas**

**and**

**Air Force Base Conversion Agency  
Williams Air Force Base  
Arizona**

**February 1996**

 **PARSONS  
ENGINEERING SCIENCE, INC.**

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9404 Genesee Ave., Suite 140 • La Jolla, California 92037

**BIOVENTING PILOT TEST WORK PLAN FOR  
LIQUID FUEL STORAGE AREA  
SITE ST-12  
WILLIAMS AIR FORCE BASE, ARIZONA**

**Prepared For**

**AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE  
BROOKS AIR FORCE BASE, TEXAS**

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# BIOVENTING PILOT TEST WORK PLAN FOR SITE ST-12 WILLIAMS AIR FORCE BASE

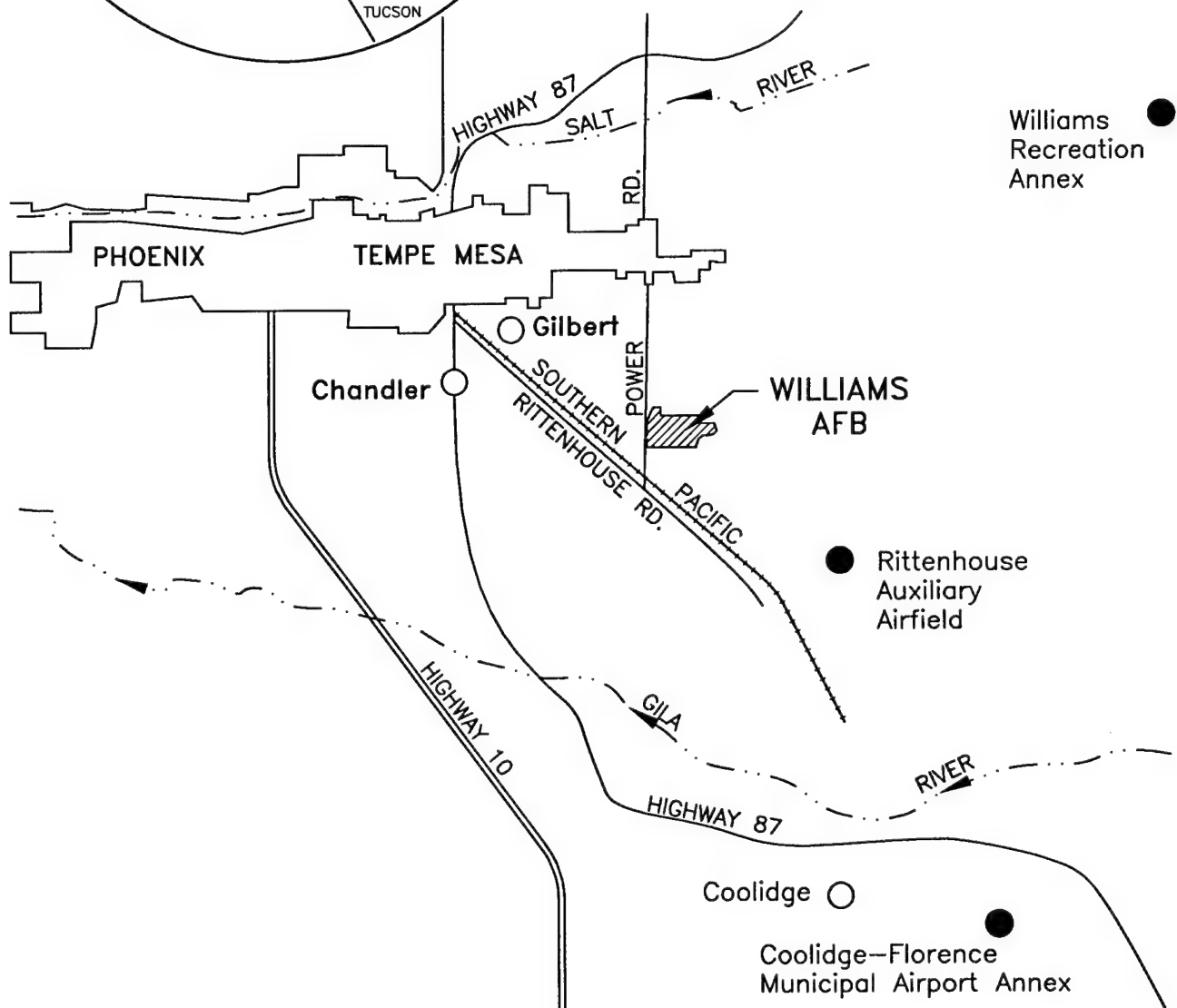
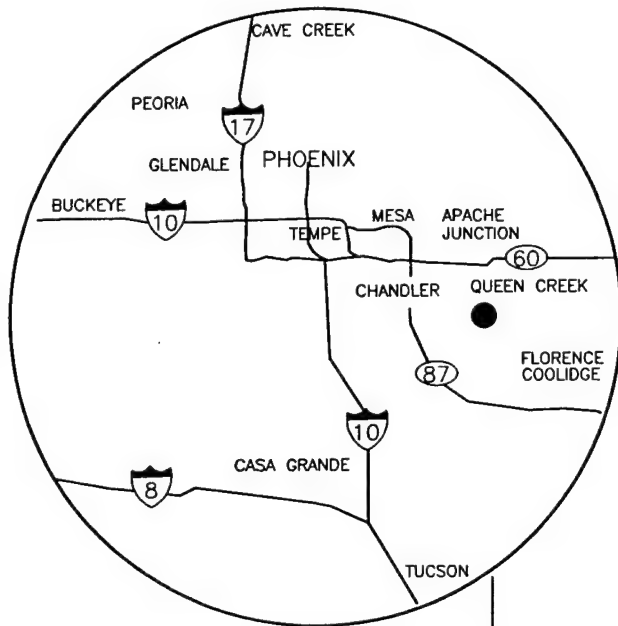
## 1.0 INTRODUCTION

This Pilot Test Work Plan presents the scope of an *in situ* bioventing pilot test for the treatment of fuel-contaminated soils at the ST-12 fuel storage area site, located at Williams Air Force Base (AFB), Arizona. Williams AFB is located in Maricopa County, 30 miles southeast of Phoenix, east of the city of Chandler, Arizona (Figure 1.1). Constructed in 1941, the primary mission throughout the Base's history was pilot training. As a result of US Department of Defense (DOD) downsizing, Williams AFB was recommended for closure, and the Base closed on September 30, 1993.

Bioventing tests have three primary objectives: (1) to assess the potential for supplying oxygen throughout the contaminated soil interval; (2) to determine the rate at which indigenous microorganisms will degrade fuel in the soil when stimulated by oxygen-rich soil gas; and (3) to evaluate the potential for sustaining these rates of biodegradation until fuel contamination is remediated to concentrations below regulatory standards.

Parsons Engineering Science, Inc. (Parsons ES) is under contract to Air Force Center for Environmental Excellence (AFCEE) to perform an initial bioventing pilot test and one year of pilot-scale bioventing system operation at Site ST-12 (Options 3 and 1 under Contract F41624-92-D-8036, Order No. 0017, also known as the AFCEE Extended Bioventing Contract). Under a different AFCEE contract (F41624-94-D-8081, Delivery Order 004), the Williams AFB environmental contractor, BEM Systems, Inc. (BEM), will be conducting a soil vapor extraction (SVE) pilot test, free product removal testing, and an intrinsic remediation study at the site. Parsons ES is subcontracted to BEM for this project and will be assisting in the coordination of bioventing/SVE testing. This work plan details the scope of work to be performed under the Extended Bioventing Contract and in support of bioventing under the Williams AFB contract. The technical approach to the pilot test is as follows:

- Under the AFCEE Extended Bioventing Contract, Parsons ES will install three vapor monitoring points (MPs) that will be used for both SVE and bioventing monitoring.
- Under the Williams AFB contract, BEM will install a vapor extraction/air injection vent well (VW) and a background MP, which will be used for both tests.
- Under the AFCEE Extended Bioventing Contract, Parsons ES will collect initial field and laboratory soil gas samples from the VW and MPs.



0 10 MILES

FIGURE 1.1

WILLIAMS AIR FORCE BASE  
LOCATION MAP

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- BEM will conduct approximately 3 weeks of SVE pilot testing using the VW and MPs.
- Assuming oxygen (O<sub>2</sub>) concentrations increase in the MPs and VW during vapor extraction testing, a respiration test will be conducted by shutting down the vapor extraction system and monitoring the decline in O<sub>2</sub> over time in the MPs and VW. The respiration test will be performed by Parsons ES under the AFCEE Extended Bioventing Contract.
- A portable air injection blower will be used by Parsons ES to conduct an air permeability test under the AFCEE Extended Bioventing Contract.
- After air permeability testing, SVE will resume until influent volatile organic compound (VOC) concentrations decline asymptotically. This task will be performed by BEM.
- When vapor extraction ceases, an air injection blower will be installed by Parsons ES at the VW, and conventional bioventing will begin under the AFCEE Extended Bioventing Contract.
- Respiration testing and soil gas sampling will be conducted by Parsons ES 1 year after the start of vapor extraction under the AFCEE Extended Bioventing Contract.

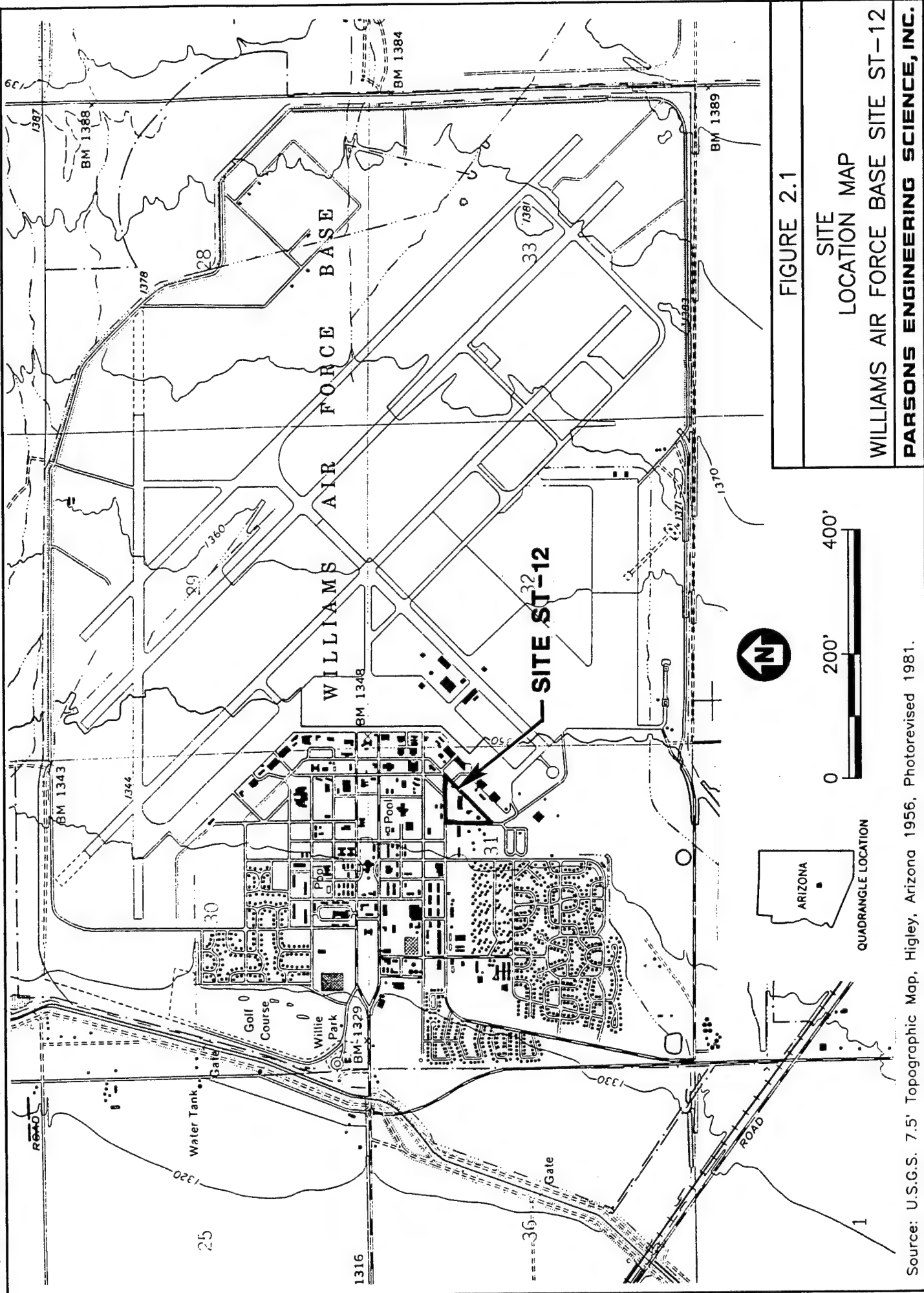
The site is contaminated to a depth of over 220 feet below ground surface (bgs) with jet fuel and highly volatile aviation gasoline (AVGAS). Treating the site first with vapor extraction will greatly reduce VOC concentrations, thus reducing the chances of volatilization, migration and surface emissions associated with injecting air into VOC-contaminated soils. If bioventing is determined to be feasible at this site, pilot test data could be used to design and implement a full-scale remediation system (if necessary) to complete site remediation, and to estimate the time required for site cleanup. Because testing will take place within the most contaminated soil at the site, an added benefit of pilot testing is that a significant amount of the fuel contamination should be biodegraded during the extended (1-year) pilot test.

Additional background information on the development and the recent success of bioventing technology is found in the *Test Plan and Technical Protocol for a Field Treatability Test for Bioventing* (Hinchee et. al., 1992). This protocol document will also serve as the primary reference for pilot test well designs and the detailed procedures that will be used during the pilot tests.

## 2.0 SITE DESCRIPTION

### 2.1 Site Location and History

ST-12 is located on the southwest side of the Base, south of A street, and east of 5th Street (Figure 2.1). Liquid fuels were stored in several tanks at ST-12 from 1942 until the tanks and distribution lines were removed in 1991. Facility 556, a 10,000-barrel JP-4 aboveground storage tank (AST), and Facility 557, a 20,000-barrel JP-4 AST, were



constructed in 1962 and 1954, respectively. Site JP-4 underground storage tanks (USTs) include Facilities 514 and 538, both of 50,000-gallon capacity, and Facility 548 consisting of ten 25,000-gallon USTs. Facility 548 also contains a 17,000-gallon AVGAS UST. Cathodic protection was installed on USTs in 1970. The 17,000-gallon AVGAS UST, located at Facility 548, was decommissioned in 1960 and filled with sand. In 1966, the Air Force updated the fuel delivery system and abandoned approximately 3,600 linear feet of 4- and 6-inch-diameter delivery pipe that remained buried. These lines were removed along with the fuel storage tanks in 1991, eliminating sources of fuel contamination. Four major spills and leaks were documented at ST-12 between 1977 and 1983. Investigations at ST-12 have been performed in different phases. Table 2.1 summarizes the work performed at ST-12.

**Table 2.1**

**Summary of Work  
ST-12, Williams Air Force Base**

Company/ Stage	Monitoring Wells		Boreholes		Soil Sample Analyzed		Soil Analysis
	Shallow (~250ft)	Deep (~350ft)	Shallow (<50ft)	Deep (>50ft)	Bore- hole	Surface Soil	
AV <sup>a</sup> , Phase II, Stage 1	--	--	8	--	37	--	Phenol, oil & grease, lead, TOX
AV <sup>b</sup> , Phase II, Stage 2	4	3	25	5	154	--	VOC, TPH, lead
IT <sup>c</sup> , RI (OU-2)	27	2	--	5	20	10	VOC, BNA, TPH, PPM, mercury
IT <sup>d</sup> , RI (OU-3)	--	--	1	15	408	--	BTEX, JP-4, TPH, TOC

<sup>a</sup> AeroVironment, 1986.

<sup>b</sup> AeroVironment, 1987.

<sup>c</sup> IT Corporation, 1992.

<sup>d</sup> IT Corporation, 1994.

## 2.2 Site Geology

There are two major soil associations found in the vicinity of the ST-12 site, the Mohall-Continue Association and Gillman-Estrella-Avondale Association soils. Both soil associations are characterized as well drained and nearly level with slopes of less than 1 percent. Site soils mostly consist of alluvial fan deposits of largely unconsolidated

gravel, sand, silt, and clay (Laney and Hahn, 1986). Previous drilling activities at the site indicate the presence of silt, sand, and silty sand. A cobble zone, varying in thickness from 5 to 50 feet, was encountered at approximately 150 feet bgs. A geologic cross-section location is shown on Figure 2.2. The cross-section is shown on Figure 2.3.

### 2.3 Site Contamination

The nature of contamination of ST-12 is from releases of Jet Propulsion Fuel Grade 4 (JP-4) and AVGAS (IT Corporation, 1992). Previous site characterization activities have detected contamination associated with former UST Facilities 514, 538, 548, and in a former distribution line leading from Facility 538 to 555. Previously drilled boreholes SB-06, SB-07, and SB-09 were placed near Facilities 538 and 548 (Figure 2.3). Hydrocarbon contamination was detected in these boreholes from approximately 15 feet bgs to the groundwater table at 220 bgs. Table 2.2 displays soil analytical data summary. Total petroleum hydrocarbons (TPH) as JP-4, benzene, and total benzene, toluene, ethylbenzene, and xylenes (BTEX) concentrations found in soil samples are listed in Table 2.3.

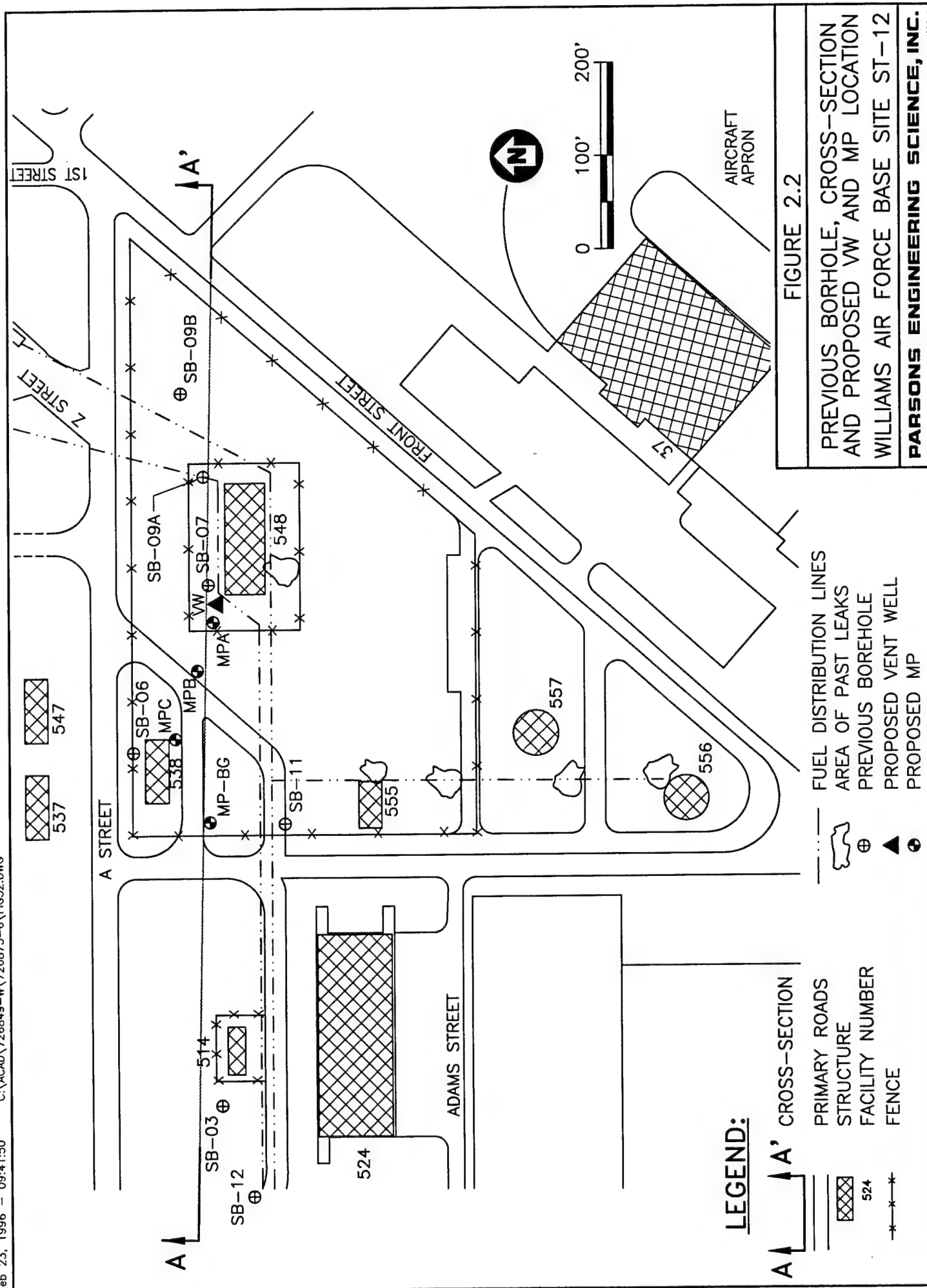
Previous site characterization activities have also detected in monitoring wells a plume of weathered JP-4 ranging in thickness from a sheen to almost 15 feet. By 1991, the leading downgradient edge of the plume was estimated to be about 350 feet east of Front Street. Product recovery activities were initiated in 1991 and are ongoing.

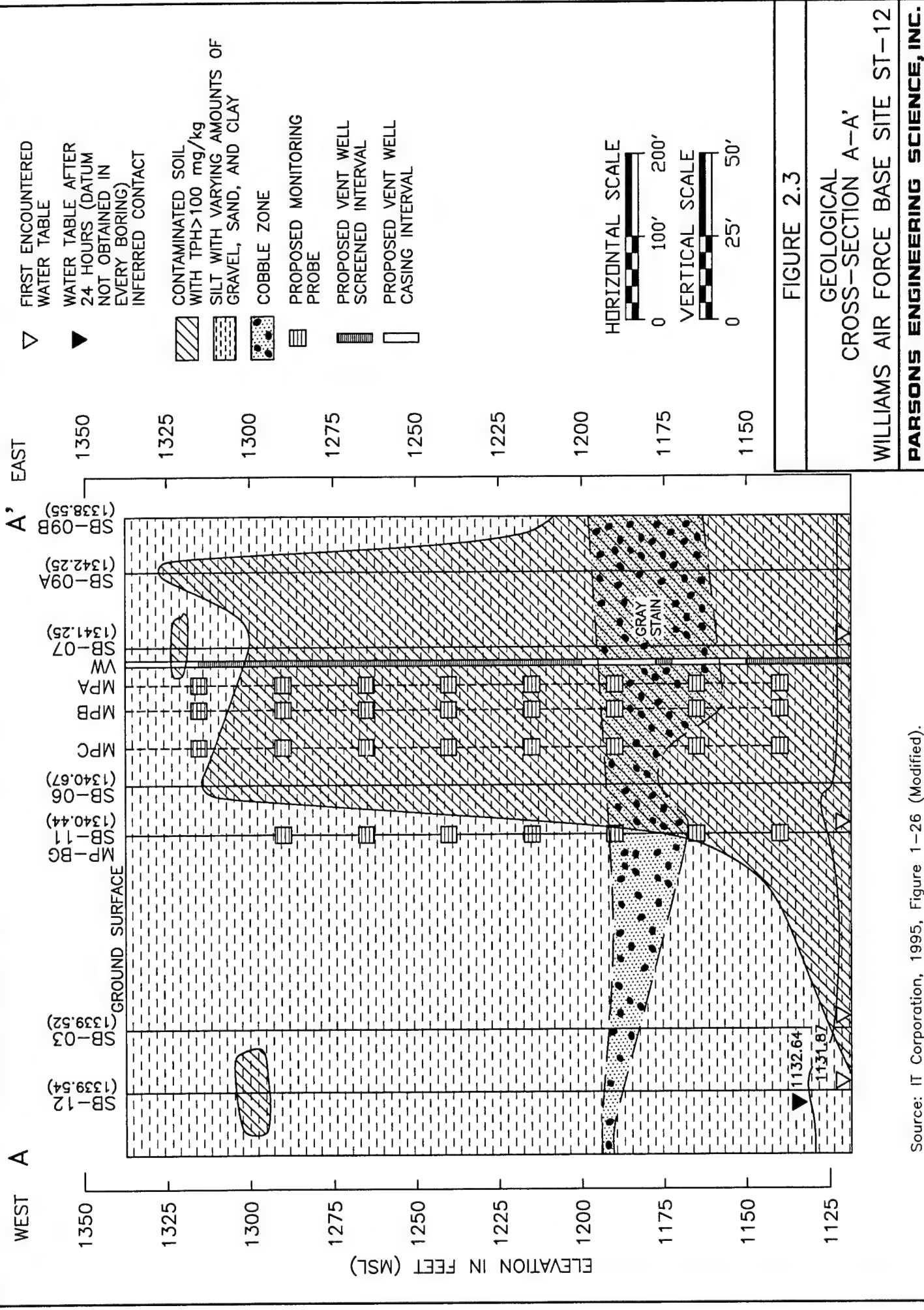
**Table 2.2**  
**1993 Deep Soil Boreholes Analytical Data Summary**  
**ST-12, Williams Air Force Base, AZ**

Analyte	Frequency of Detection	Range of Detected Concentrations (mg/kg)	Upper 95% Confidence Limit Concentration (mg/kg)
Benzene	245/354	0.005-370	17
Toluene	261/354	0.005-870	60
Ethylbenzene	211/354	0.005-270	19
Total Xylenes	251/354	0.0053-720	57
TPH as JP-4	227/354	0.42-35,000	1,700

Source: IT Corporation, 1995.







**Table 2.3**  
**TPH as JP-4, Benzene and BTEX**  
**Concentrations in mg/kg**  
**ST-12, Williams Air Force Base, AZ**

Depth ft(bgs)	Borehole ID								
	SB-06			SB-07			SB-09		
	JP-4	Benz	BTEX	JP-4	Benz	BTEX	JP-4	Benz	BTEX
5	1U <sup>a</sup>	0.005U	-	2	0.005U	0.169	0.7	0.005U	0.0052
15	1U	0.005U	-	500	2.6	44.6	4.6	0.029	0.463
25	3000	1.2	186.2	4	0.1	0.501	1U	0.005U	-
35	2300	0.005U	178	56	0.18	4.09	1U	0.005U	-
45	5500	7.6	669.6	4600	35	735	1U	0.005U	0.0025
55	9000	12	1012	6300	110	783	4.3	0.089	0.395
65	6900	19	803	5000	140	980	1U	0.005U	-
75	2600	5.2	215.2	2300	40	380	1U	0.005U	0.024
85	2900	10	160	3800	56	564	2.7	0.73	1.65
95	5000	15	210	3600	99	494	4.5	0.2	1.01
105	6000	48	360	2100	33	223	14	1.4	3.82
115	2800	21	120	2300	71	351	1.8	0.14	0.42
125	3000	12	130	3900	120	742	8.2	1	2.66
135	4700	39	220	2300	110	548	1300	33	210
145	1700	4.7	96	830	8.8	129.8	340	6.6	53
155	1800	6.7	81	900	19	134.6	220	0.87	28.77
165	1000	5	23	2700	81	635	15000	300	2110
175	3900	22	240	1500	26	246	1U	0.005U	97
185	5400	78	260	2200	62	464	22	3.2	7.73
195	3.6	7.8	34	23	1.9	7.52	11	1.1	3.17
205	25	0.42	.89	3100	33	464	1.2	0.072	0.204
215	3100	65	280	3300	71	692	7600	140	1090

Source: IT Corporation, 1994.

<sup>a/</sup> U indicates that results are less than detection limits.

### 3.0 SITE-SPECIFIC ACTIVITIES

The purpose of this section is to describe the bioventing test that will be performed at Site ST-12. Activities at the site will include: (1) siting and constructing a central vapor extraction/air injection VW (to be installed by BEM under the Williams AFB contract), three vapor MPs (to be installed by Parsons ES) and a background MP (to be

installed by BEM); (2) conducting an air permeability test; (3) conducting an *in situ* respiration test; and (4) implementing an extended (1-year) bioventing pilot test. Soil and soil gas sampling procedures are described below. In addition, the blower configuration that will be used to inject ambient air into contaminated soils through the VW is also discussed in this section.

### 3.1 Location and Construction of Vent Well and Vapor Monitoring Points

A general description of criteria for siting a VW and MPs is included in the protocol document. Figure 2.2 indicates the proposed location of the VW and MPs at this site. The final location of the VW and MPs may vary slightly from the proposed location if significant fuel contamination is not observed during drilling. The VW will be located in the area of highest detected fuel contamination based on previous site investigation sampling data. This area is expected to have TPH concentrations of up to 35,000 mg/kg. Soils in this area are expected to be oxygen depleted (<2 percent O<sub>2</sub>), and increased biological activities should be stimulated by oxygen-rich soil gas ventilation initially during vapor extraction, and subsequently with air injection.

Based on previous site characterization information, soil contamination extends vertically from approximately 25 feet bgs to 220 feet bgs and laterally approximately 200 feet from the center of the contamination detected in boreholes SB-06, SB-07, and SB-09. The radius of oxygen influence around the VW is anticipated to be approximately 110 feet. MPA, MPB, and MPC will be located within a 120-foot radius of the VW. The background MP will be located beyond the extent of contamination, approximately 220 feet from the VW near borehole SB-11 (Figure 2.2).

The VW and MPs will be installed using an air rotary casing hammer or a roto sonic drill rig. The VW or MPA (whichever is drilled first) will be continuously sampled. This will ensure detailed lithologic control, which is essential for a properly designed system. A GasTech<sup>TM</sup> GT Series Gas Monitor will be used to screen for fuel vapors in the headspace of soil samples collected during drilling activities. This platinum-catalyst combustion detector is calibrated with hexane, which provides a conservative reading representative of total volatile hydrocarbon (TVH) vapors present in soil sample headspace. Field screening results will be recorded on a geologic borehole log, and will be reported in the bioventing interim test results report.

A construction diagram for the VW is shown on Figure 3.1. Because the VW also will be used for groundwater monitoring and possible product recovery as part of BEMs site activities, it will be constructed of 4-inch inside-diameter (ID) Schedule 40 polyvinyl chloride (PVC) casing and type 304 stainless steel 0.02-inch slotted screen. To prevent preferential flow through the cobble zone previously encountered between approximately 140 and 190 feet bgs, blank casing will be installed through most of this interval. To allow some flow, a 5-foot section of PVC screen will be installed through the center of this interval. Groundwater levels have been rising at the site at a rate of up to 5 feet per year. To allow for groundwater sampling, product recovery, vapor extraction, and air injection several years into the future, the screen interval will extend from 230 feet bgs (approximately 10 feet below the current groundwater table) to 190 feet bgs. Additional

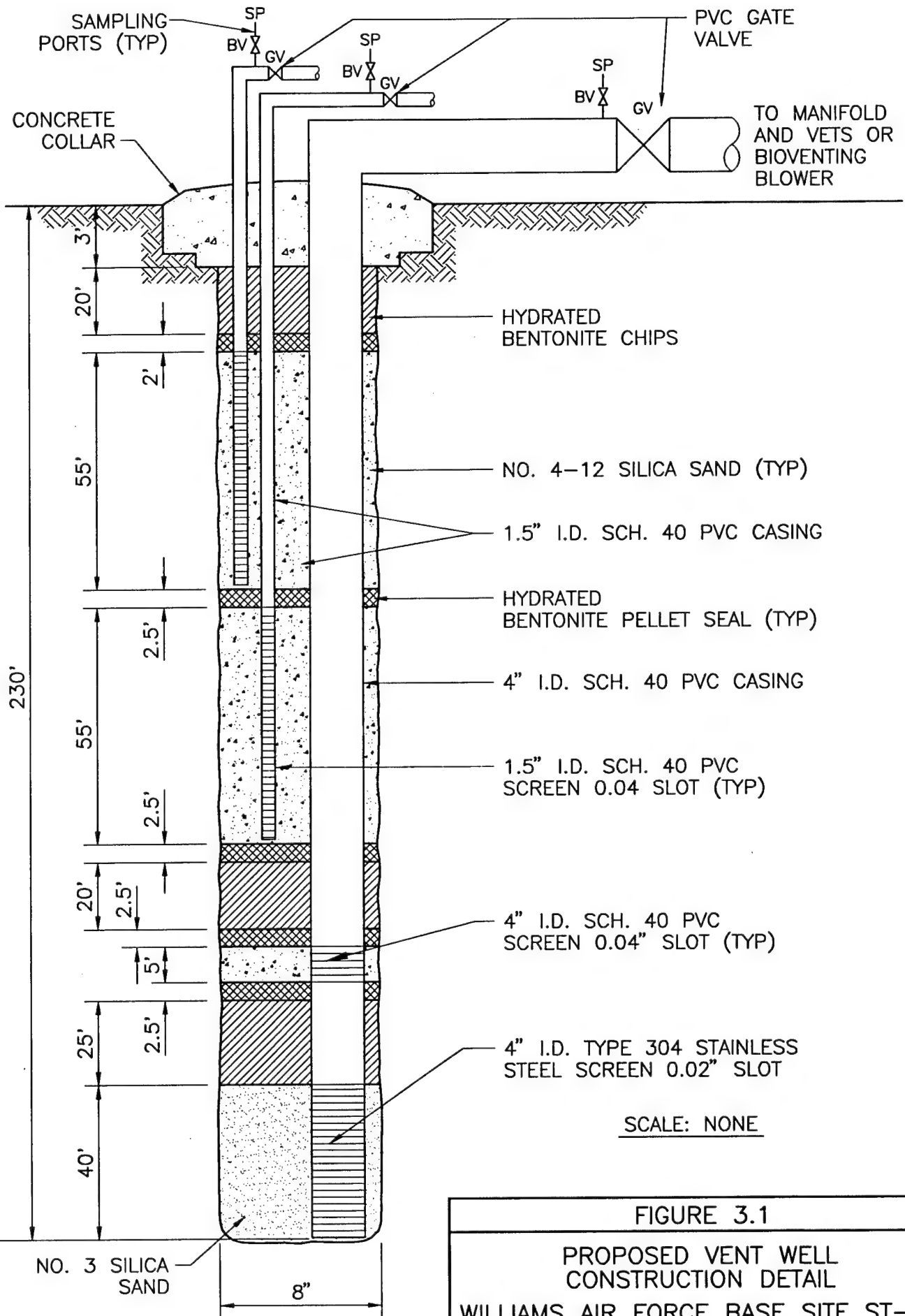


FIGURE 3.1

PROPOSED VENT WELL  
CONSTRUCTION DETAIL

WILLIAMS AIR FORCE BASE SITE ST-12

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screen and casing assemblies will be installed in the same borehole to allow for vapor extraction and air injection between 25 feet and 140 feet bgs (Figure 3.1). One assembly will be screened from approximately 137.5 to 82.5 feet bgs. The other will be screened from 80 to 25 feet bgs. In order to fit in the same borehole, the two additional well assemblies will consist of 1.5-inch ID Schedule 40 PVC casing and 0.04-inch slotted screen. Each screened interval will be separated by a 2.5-foot-thick bentonite pellet seal. These interscreen seals will help prevent the filter pack from acting as a conduit to the water table should perched product be encountered. The nested well configuration will also provide greater control for interval-specific vapor extraction and air injection.

Flush-threaded casing and screen will be installed without using organic solvents or glues. The filter pack will consist of clean, No. 3 size or equivalent silica sand for the 4-inch-diameter 0.02-inch slotted screen, and 4-12 size sand for the 1.5-inch-diameter 0.04-inch slotted screen. The filter pack will be placed in the annular space of the screen interval. A 2.5-foot-thick layer of bentonite pellets, hydrated in place with potable water, will be placed directly over the filter pack between each screen interval. A 20-foot-thick bentonite chip seal, also hydrated in place, will be placed above the uppermost bentonite pellet seal. The surface seal will be completed with a 3-foot-thick concrete collar, extending from the top of the bentonite chip seal to approximately 2 inches above grade. A complete seal is critical to prevent injected air from short circuiting to (or from) the surface during the bioventing (or vapor extraction) test.

A typical multi-depth MP installation for this site is shown on Figure 3.2, and the proposed MPs are shown on Figure 2.2. Oxygen and carbon dioxide soil gas concentrations, vacuum (during vapor extraction testing), and pressure (during bioventing air permeability testing) will be monitored via vapor monitoring screens placed at depth intervals of 50, 75, 100, 125, 150, 175, and 200 feet bgs. Depth intervals may vary in order to ensure each major lithology type encountered during drilling receives a probe. Multi-depth monitoring will assess whether the entire soil profile is receiving oxygen and will be used to measure fuel biodegradation rates at all monitored depths. The annular space between the vapor monitoring screen filter packs will be sealed with bentonite chips completely hydrated in place to isolate the monitoring intervals. Several inches of bentonite pellets will be used directly above and below the filter pack intervals. In vapor MPA, thermocouples will be installed at the deepest and shallowest screens to measure soil temperatures. Additional details on VW and MP construction are found in the Section 4 of the protocol document.

### **3.2 Handling of Drill Cuttings**

Soil cuttings generated during drilling will be placed on and covered with plastic sheeting. When borehole activities are completed, contaminated cuttings will be collected and transported to the Base Investigative Waste Facility (IWF) by the drilling subcontractor.

Decontamination fluid generated during site activities will be disposed of at the Base decontamination pad. The fluids will be allowed to evaporate.



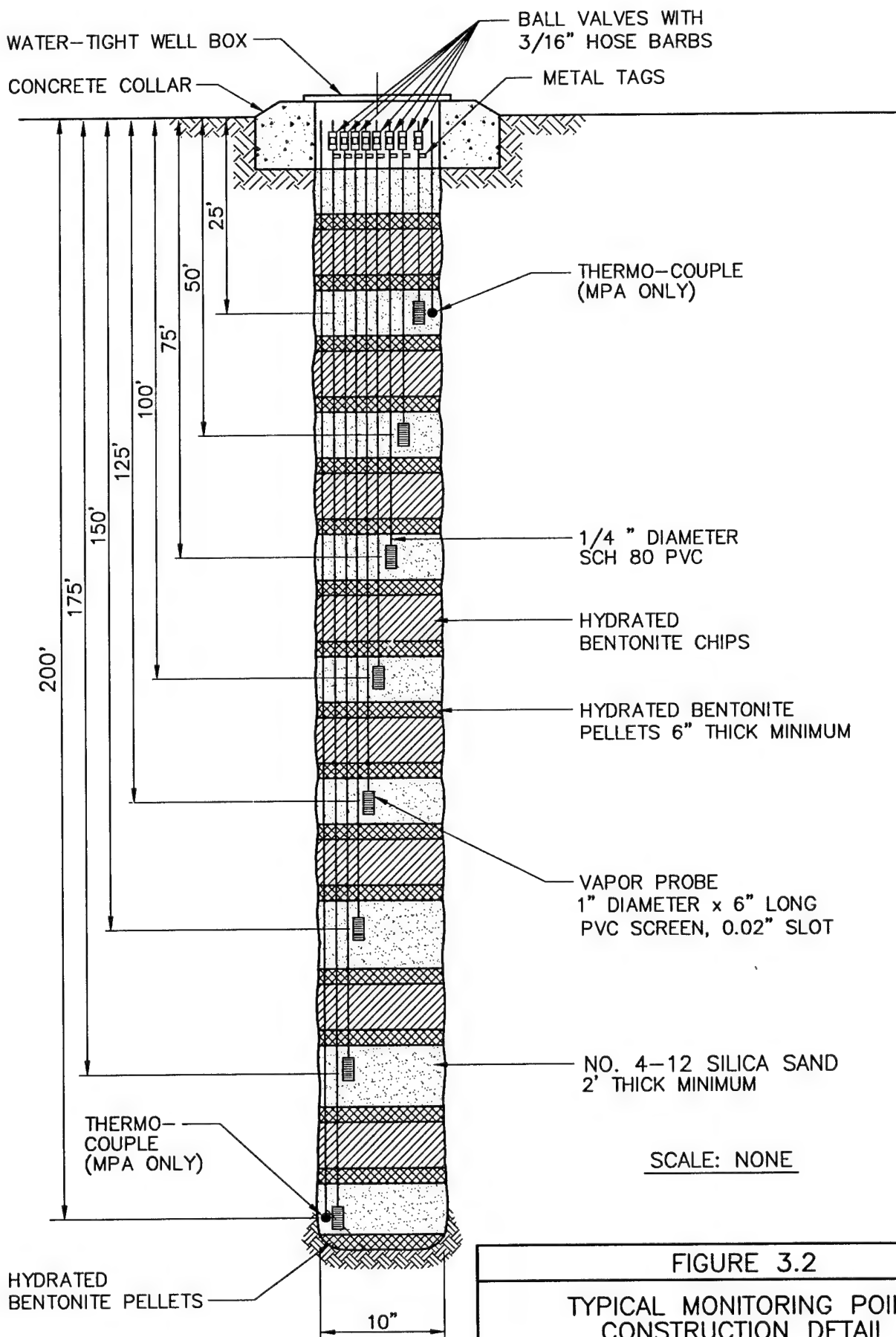


FIGURE 3.2

TYPICAL MONITORING POINT CONSTRUCTION DETAIL

WILLIAMS AIR FORCE BASE SITE ST-12

PARSONS ENGINEERING SCIENCE, INC.

### **3.3 Soil and Soil Gas Sampling**

#### **3.3.1 Soil Samples**

Under the AFCEE Extended Bioventing Contract, Parsons ES will collect six soil samples during the installation of the MPs. Sampling procedures will follow those outlined in the protocol document. A GasTech<sup>TM</sup> GT Series Gas Monitor will be used during drilling to screen soil samples for determining intervals of high fuel contamination. Samples will be collected from the two most contaminated intervals of each MP. These soil samples will be analyzed for total recoverable petroleum hydrocarbons (TRPH) and BTEX by US Environmental Protection Agency (EPA) Method 8015 modified for JP-4 and EPA Method 8020, respectively. Three of these samples will be analyzed for soil moisture, pH, grain-size distribution, porosity, bulk density, alkalinity, total iron, total Kjeldahl nitrogen (TKN), and total phosphorus by methods ASTM D2216, SW9045, ASTM D422, AP1-RP40, ASTM SM210B, E310.1M, SW6010, E351.2M, and E365.2, respectively. An additional soil sample will be collected from representative soils in the background MP and analyzed for TKN in order to characterize the noncontaminated, baseline soil nutrient conditions.

Soil samples will be collected using a split-spoon sampler containing brass tube liners. Sample tube ends will be sealed with Teflon<sup>®</sup> sheets held in place by plastic caps. Soil samples will be labeled following AFCEE Installation Restoration Program Information Management System (IRPIMS) nomenclature, sealed in a locking plastic bag, and placed in a cooler for shipment. A chain-of-custody form will be completed, and the cooler will be shipped to Southwest Laboratories in Oklahoma City, Oklahoma. This laboratory has been audited by the Air Force and meets all quality assurance/quality control (QA/QC) and certification requirements for the State of Arizona.

#### **3.3.2 Soil Gas Samples**

Soil gas in the VW and each MP will be sampled by Parsons ES and analyzed using field instruments. A GasTech<sup>TM</sup> GT Series Gas Monitor will be used to measure O<sub>2</sub>, CO<sub>2</sub>, and TVH concentrations at each location. Also, six initial soil gas samples will be collected in SUMMA<sup>®</sup> canisters for laboratory analysis, in accordance with the Bioventing Field Sampling Plan (Engineering-Science, 1992). These samples will be collected from the VW, MPA, and MPC. Samples will be collected from the points with the highest TVH and lowest O<sub>2</sub> concentrations. The soil gas samples will be used to determine the reduction in BTEX and TVH during the 1-year tests, and to detect any migration of these vapors from the source area.

Soil gas sample canisters will be placed in a small cooler and packed with foam pellets to prevent excessive movement during shipment. In order to prevent condensation of hydrocarbons, samples will not be preserved on ice. A chain-of-custody form will be completed, and the cooler will be shipped to the Air Toxics, Inc. in Folsom, California, where the samples will be analyzed by EPA Method TO-3 for TVH and BTEX.

Following initial soil gas sampling, BEM will develop, purge, and sample the 4-inch-ID section of the VW. If floating product is encountered, BEM will perform a



limited product baildown test. After groundwater sampling and product baildown testing (if any), BEM will conduct approximately 3 weeks of vapor extraction pilot testing. The existing site thermal oxidation unit will be used to treat the extracted vapors.

As part of the test, BEM will monitor the effects of vapor extraction on product recovery. To meet local air monitoring requirements, BEM will collect vapor treatment system influent and effluent samples in SUMMA<sup>®</sup> canisters for analysis by EPA Method TO-3 for TVH and BTEX.

During the test, Parsons ES and BEM will monitor O<sub>2</sub>, CO<sub>2</sub>, and TVH concentrations at each MP, the VW, and at the vapor treatment system influent and effluent ports. As clean soil gas from outside the zone of contamination is drawn through the site toward the VW during vapor extraction, it is anticipated that O<sub>2</sub> concentration in the MPs and VW will increase sufficiently to conduct a respiration test by turning off the vapor extraction system and monitoring the MPs and VW as described in Subsection 3.4. Also, by comparing the changes in O<sub>2</sub> concentration as soil gas moves from the background MP to the VW, an estimate of the component of *in situ* remediation occurring during vapor extraction can be made.

### 3.4 *In Situ* Respiration Tests

The objective of *in situ* respiration test is to determine the rate at which soil bacteria degrade petroleum hydrocarbons in the presence of oxygen. Respiration tests will be performed at the VW and all MPs where O<sub>2</sub> has increased to at least 10 percent during the 3-week vapor extraction testing period. Baseline O<sub>2</sub>, CO<sub>2</sub>, and TVH samples will be collected while the vapor extraction system is operating. The system then will be turned off, and O<sub>2</sub>, CO<sub>2</sub>, and TVH levels will be monitored for the following 72 to 96 hours. The decline in O<sub>2</sub> concentrations over time will be used to estimate rates of bacterial degradation of fuel residuals. Additional details on the *in situ* respiration test are provided in Section 5.7 of the protocol document (Hincbee *et. al.*, 1992).

### 3.5 Air Permeability Tests

An air permeability test will be conducted after completing the respiration test. The objective of air permeability tests is to determine the areal extent of the subsurface soils (radius of influence) that can be oxygenated using one air injection VW. Air will be injected into the VW using a 1-horsepower blower unit. Pressure response will be measured for 4 to 6 hours at each MP using differential pressure gauges to determine the regional influence of the blower unit. Oxygen concentrations in the MPs will be monitored over the next few days and flow rates will be adjusted accordingly to determine the minimum flow rate needed provide sufficient O<sub>2</sub> throughout the contaminated soil zone.

After the air permeability test is complete, the blower will be disconnected from the VW. Shortly thereafter, Parsons ES and BEM will re-start the vapor extraction system. BEM will operate this system until VOC concentrations in the extracted vapors decrease asymptotically (approximately 4 to 6 months).

### 3.6 Blower Systems

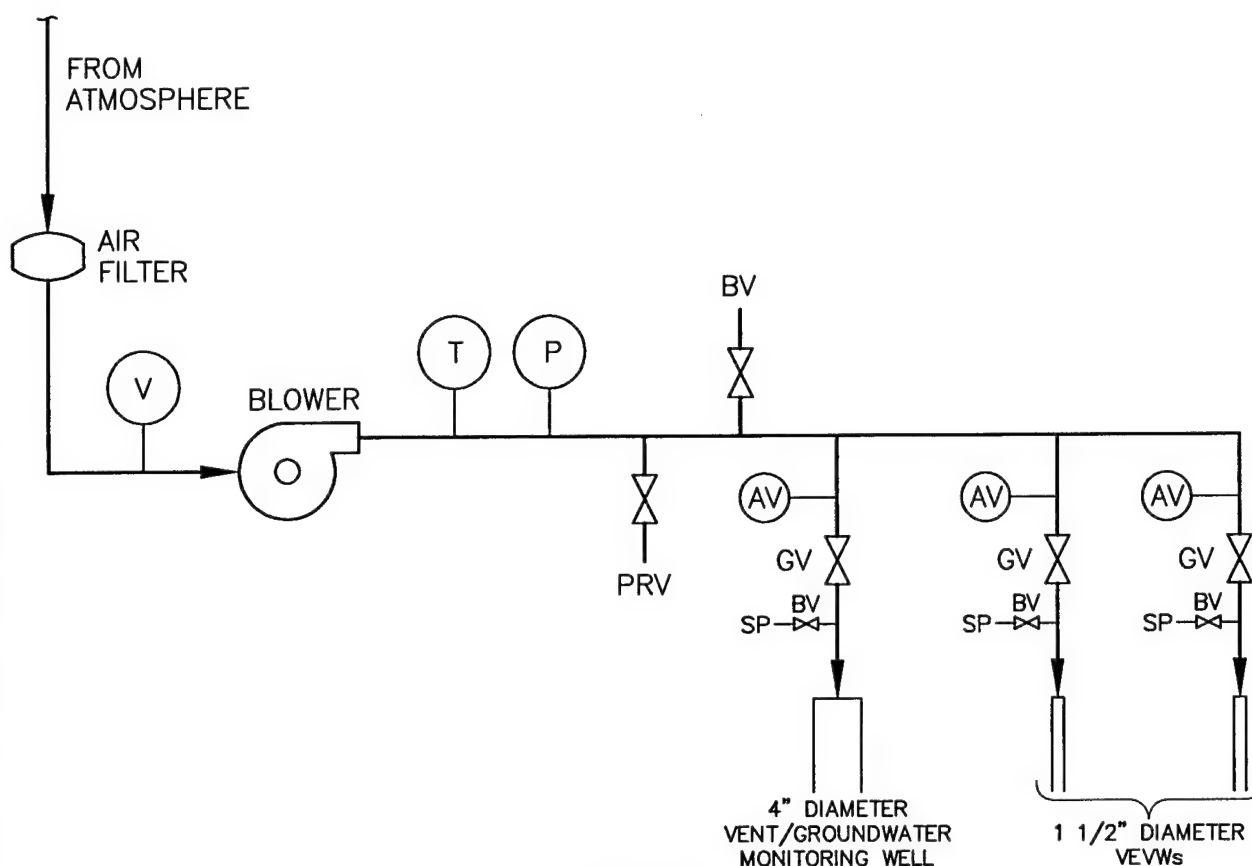
A 1-horsepower regenerative blower, capable of injecting 50 standard cubic feet per minute (scfm) at 40 inches of water, will be used to conduct the initial air permeability test. A schematic diagram of a typical air injection system used for pilot testing is shown on Figure 3.3. The maximum power requirement anticipated for this pilot test is 230-volt, single-phase, 30-amp service. Additional power supply requirement details are described in Section 5.0, Base Support Requirements.

### 3.7 Air Emission Monitoring







Since June 1995, a shallow vapor extraction system has been operating at the site. Vapors are treated with an on-site thermal oxidation unit. This shallow system has been extracting VOCs at the site to a depth of approximately 25 feet bgs. Over the 7-month period of operation, extracted vapor VOC concentrations have dropped from about 50,000 to 2,500 parts per million, volume per volume (ppmv) TVH, as measured with field instruments. It appears as if the majority of the most volatile compounds have been removed from the top 25 feet. The source of the 2,500 ppmv VOCs still being recovered by the system is most likely the remaining 200 feet of contaminated soil. The shallow system will soon be taken off-line.

As previously described, the VW will be used for vapor extraction for approximately 4 to 6 months. With the exception of a short-term (2 to 3 days) air permeability test, air will not be injected into the VW for bioventing until after most of the VOCs have been removed from the subsurface by the vapor extraction system. The proposed bioventing system will inject air into the VW at a very low flow rate (approximately 80 scfm over 190 feet of screen) to provide O<sub>2</sub> for enhanced biodegradation. The top of the shallowest VW screened interval will be 25 feet bgs (Figure 3.1). Above the screen will be a 25-foot-thick bentonite and concrete seal. Because horizontal permeability is generally greater than vertical permeability, the injected air will tend to move outward rather than upward. This will promote *in situ* biodegradation of fuel vapors as they move slowly outward from the VW. If some upward movement of injected air does occur, it will have to migrate through the 25-foot-thick zone of soil recently treated by the shallow vapor extraction system. Therefore, no surface emissions of VOCs are expected to result from bioventing. Only the air monitoring activities described below are proposed.

Parsons ES will carefully monitor the air in the breathing zone during the first day of air permeability testing, and a photoionization detector (PID) will be used to detect any VOC emissions exceeding ambient conditions. PID readings will be collected at 15-minute intervals at the wellheads and in the worker breathing zone. The PID will be calibrated with isobutylene to detect BTEX compounds at the 1-ppmv level. This level of detection is consistent with the most conservative regulatory standard. Any sustained PID reading in excess of 1 ppmv will require an immediate reduction in air injection rates.



#### LEGEND

-  - INLET AIR FILTER GAST<sup>®</sup> A9338
-  - VACUUM GAUGE (-60 - 0 IN. H<sub>2</sub>O) GAST<sup>®</sup> AJ 497
-  - BLOWER GAST<sup>®</sup> R4110-2 REGENERATIVE BLOWER
-  - TEMPERATURE GAUGE (0 - 250°F) ASHCROFT<sup>®</sup> 30E 160R 025
-  - PRESSURE GAUGE (0 - 60 IN. H<sub>2</sub>O) GAST<sup>®</sup> AJ 496
- PRV - PRESSURE RELIEF VALVE GAST<sup>®</sup> AG 258 (SET TO RELEASE AT 40 IN. H<sub>2</sub>O PRESSURE)
- BV - BALL VALVE
- GV - GATE VALVE
-  - AIR VELOCITY PORT
- SP - SOIL GAS SAMPLING PORT

SCALE: NONE

FIGURE 3.3

BLOWER SYSTEM INSTRUMENTATION  
DIAGRAM FOR AIR INJECTION  
WILLIAMS AIR FORCE BASE SITE ST-12

**PARSONS ENGINEERING SCIENCE, INC.**

### **3.8 Installation of Extended (1-Year) Pilot Test Bioventing System**

An extended (1-year) bioventing pilot test system will be installed at the site if the initial pilot tests successfully demonstrate the feasibility of providing oxygen throughout the contaminated soil profile. Because a measurable component of *in situ* biodegradation is anticipated to occur during operation of the vapor extraction system, the 1-year testing period will include the period of vapor extraction. After the vapor extraction system is removed, the extended bioventing system will be installed at the site. As part of extended pilot test systems, a fixed blower unit will be installed in a small wooden shed that will be located on top of the VW. The blower will deliver air to the VW at a total flow rate of approximately 80 scfm. Continued air injection would determine the long-term radius of oxygen influence, and the effects of time, available nutrients, and changing temperature on fuel biodegradation rates. At the end of 1 year of vapor extraction and bioventing, the system will be turned off for 1 month to allow soil gas conditions to equilibrate. Soil gas samples then will be collected in SUMMA<sup>®</sup> canisters from the VW and MPs originally sampled during initial testing. The samples will be analyzed by EPA Method TO-3 for TVH and BTEX. After soil gas sampling, Parsons ES will conduct a respiration test. The test will be conducted by injecting air into selected MPs using 1-scfm pumps for 20 hours. After the air injection period, O<sub>2</sub>, CO<sub>2</sub>, and TVH concentrations will be monitored for approximately 2 to 4 days. After completing the respiration test, the bioventing blower will be turned on and reoptimized.

### **4.0 EXCEPTIONS TO PROTOCOL PROCEDURES**

There are several exceptions to the protocol procedures. Most of the exceptions are due to combining a bioventing pilot test with a vapor extraction test, groundwater sampling, and possibly product recovery. The exceptions are as follows:

1. The VW will be completed into the water table to allow for groundwater sampling and possible product recovery. Also, the VW design will include three nested wells screened over different intervals, separated by bentonite seals. This configuration will provide greater control during vapor extraction and air injection activities. The bentonite seals will prevent the filter sand from providing a conduit for the downward migration of perched product (if any).
2. A 3-week period of testing, including groundwater sampling, product recovery testing, and vapor extraction, will be conducted before the respiration or air permeability tests are completed.
3. Air and the helium tracer gas will not be injected into selected MPs prior to the respiration test. Instead, the increase in O<sub>2</sub> throughout the site due to vapor extraction is anticipated to be sufficient to allow for respiration testing. The vapor extraction system will be turned off, and the soil gas will be monitored over time in accordance with the protocol document.
4. After the air permeability test, the vapor extraction system will be re-started and will continue to operate as long as extracted vapor VOC concentrations remain high enough to allow system operation with a minimum of supplemental

fuel (natural gas or propane). A 4- to 6-month operation period is anticipated. However, if the system should remain operating for the year-long testing period, year-end soil gas sampling and respiration testing will still be completed as described in Subsection 3.8.

## **5.0 BASE SUPPORT REQUIREMENTS**

The following Base support is needed prior to arrival of the drilling subcontractor and the Parsons ES pilot test team:

- Coordinate this work plan with local regulatory agencies and advise if any additional permits or information are required.
- Obtain a Base digging permit.
- Confirm an available power source, and install a 230-volt, 30-amp, single-phase breaker box with one 110-volt receptacle and two 110-volt receptacles outside the blower shed at the VW.
- Provide paperwork (if any) required to obtain gate passes and security badges for 24-hour Base and site access for three Parsons ES personnel.
- Provide keys to any locked gates restricting access to the site (if any).

During the 1-year pilot test, Base personnel will be required to check the blower system once per week to ensure that it is operating properly. During this check, it will be necessary to (1) record the air injection system pressure and temperature, and (2) change the air filter as needed. Parsons ES will provide a brief training session for this procedure and the maintenance procedure manual with the data collection sheet.

## **6.0 PROJECT SCHEDULE**

The following schedule is contingent upon approval of this pilot test work plan and completion of Base support requirements listed in Section 5.

<u>Event</u>	<u>Date</u>
Draft Pilot Test Work Plan to AFCEE	23 February 1996
Approval to Proceed	8 March 1996
Begin Initial Pilot Test	April 1996
(Due to extensive Base and regulatory submittal requirements for other work planned for the site, VW installation and vapor extraction testing anticipated to begin in mid-April 1996)	
Interim Results Report	May 1996
Final Soil Gas Sampling and Respiration Testing	April 1997

## **7.0 POINTS OF CONTACT**

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(303) 831-8208 (FAX)

## **8.0 REFERENCES**

AeroVironment, Inc. 1986. Installation Restoration Program, Phase II Confirmation/  
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**APPENDIX B**

**BOREHOLE LOGS**



# WILLIAMS AFB ST-12 BIOVENTING PILOT TEST

PAGE 1 OF 5

PROJECT NO: 726876 SITE NO: ST-12

BOREHOLE NO: MPA

PROJECT NAME: WILLIAMS AFB

DATE BEGAN: 9/26/96

DATE FINISHED: 9/26/96

FIELD GEOLOGIST: L. DUJUS

DRILLER: LAYNE ENVIRONMENTAL SERVICES

NORTH: UNKNOWN

EAST: UNKNOWN

GROUND SURFACE ELEV.: 1341 feet

GWL DATE/TIME: N/A

GWL DEPTH: N/A

DRILLING METHOD: DUAL-WALL PERCUSSION HAMMER (9" OD)

DRILL EQUIP: AP-1000

GWL EQUIP: N/A

CONTRACTOR: PARSONS ENGINEERING SCIENCE

CHECKED BY: A.J.S.

CONTRACTOR: PARSONS ENGINEERING SCIENCE									
ELEV (FT)	DEPTH (FT)	BLOW COUNT	PERCENT RECOVERY	PROFILE	DESCRIPTION	U. S. S.	VOLATILE ORGANIC VAPORS (ppm)		REMARKS
							PID		
-1340.0	0.00								
-1335.0	-5.00	18/25/25	90		SILT: brown (7.5YR5/4), some sand, very fine, dry.	ML	0.0		no odor
-1330.0	-10.00	19/24/26	90		SILT: brown (7.5YR5/4), some sand, very fine, dry.	ML	0.0		no odor
-1325.0	-15.00	10/12/ 50-2	80		SILT AND SAND: brown (7.5YR5/4), very fine to medium, very slightly damp.	SM	0.0		no odor
-1320.0	-20.00	44/50-3"	40		SILT: brown (7.5YR5/4), some sand, very fine, very slightly damp.	ML	0.0		no odor
-1315.0	-25.00	18/50-5"	70		SAND AND SILT: brown (7.5YR5/4), very fine to fine, very slightly damp.	SM	0.0		no odor
-1310.0	-30.00	27/50-5"	60		SILT: brown (7.5YR5/4), some sand, very fine, very slightly damp.	ML	0.0		no odor
-1305.0	-35.00	20/23/26	100		SAND: brown (7.5YR5/4), very fine, some silt, very slightly damp.	SM	0.0		no odor, gravel in cuttings
-1300.0	-40.00								

# WILLIAMS AFB ST-12 BIOVENTING PILOT TEST

PROJECT NO: 726876 SITE NO: ST-12 BOREHOLE NO: HPA OF 5  
 DATE BEGAN: 9/26/96 DATE FINISHED: 9/26/96 PROJECT NAME: WILLIAMS AFB  
 DRILLER: LAYNE ENVIRONMENTAL SERVICES NORTH: UNKNOWN FIELD GEOLOGIST: L. DUDUS  
 GROUND SURFACE ELEV.: 1341 feet GWL DATE/TIME: N/A EAST: UNKNOWN  
 DRILLING METHOD: DUAL-WALL PERCUSSION HAMMER (9" OD) DRILL EQUIP: AP-1000 GWL DEPTH: N/A  
 CONTRACTOR: PARSONS ENGINEERING SCIENCE CHECKED BY: A.J.S.

ELEV (FT)	DEPTH (FT)	BLOW COUNT	PERCENT RECOVERY	PROFILE	DESCRIPTION	U: S: S:	VOLATILE ORGANIC VAPORS (ppm)	PID	REMARKS
-1300.0	-41.00	23/25/ 50-2	70		SILT: light brown (7.5YR6/4), some sand, very fine, very slightly damp.	ML	0.0		no odor
-1295.0	-46.00	19/50-3"	30		CALICHE: light brown (7.5YR6/4), some silt, brown (7.5YR5/4), some sand, very fine, slightly damp.	--	0.0		no odor
-1290.0	-50.00	24/50-5"	60		SAND: brown (7.5YR5/4), very fine, some silt, very slightly damp.	ML	0.0		no odor
-1285.0	-55.00	12/26/30	70		SILT: brown (7.5YR5/4), some caliche, cobble, very slightly damp.	ML/GM	23		no odor, new baggies, 14 ppm baggie hits
-1280.0	-60.00	15/17/19	90		SAND AND SILT: brown (7.5YR5/4), medium to very fine, very slightly damp.	SM	18		no odor
-1275.0	-65.00	6/11/15	80		SILT: brown (7.5YR5/4), little sand, medium to very fine, trace pebbles, trace caliche, very slightly damp.	ML/GM	22		no odor
-1270.0	-70.00	7/30/35	80		SILT: brown (7.5YR5/4), little caliche, little sand, medium to fine, very slightly damp.	ML	40		no odor
-1265.0	-75.00	11/18/27	70		CALICHE: pinkish grey (7.5YR7/2), up to 3" thick, some silt, very slightly damp.	--	9.0		no odor, sandy gravel in cuttings
-1260.0	-80.00								

PAGE 3 OF 5

PROJECT NAME: WILLIAMS AFB

**FIELD GEOLOGIST: L. DUDUS**

EAST: UNKNOWN

**GWL DEPTH:** N/A

**GWL EQUIP:** N/A

**CHECKED BY: A.J.S.**

-120.08-

PAGE 9

PROJECT NO: 726876 SITE NO: ST-12

BOREHOLE NO: MPA

PROJECT NAME: WILLIAMS AFB

DATE BEGAN: 9/26/96

DATE FINISHED: 9/26/96

**FIELD GEOLOGIST: L. DUDUS**

**DRILLER: LAYNE ENVIRONMENTAL SERVICES**

**NORTH: UNKNOWN**

EAST: UNKNOWN

GROUND SURFACE ELEV.: 1341 feet

GWL DATE/TIME: N/A

**GWL DEPTH:** N/A

# ORTHOLING METHOD: DUAL-WALL PERCUSSION HAMMER (9" OD)

**DRILL EQUIP: AP-1000**

GWL EQUIP: N/A

**CONTRACTOR: PARSONS ENGINEERING SCIENCE**

CHECKED BY: A.J.S.

ELEV (FT)	DEPTH (FT)	BLOW COUNT	PERCENT RECOVERY	PROFILE	DESCRIPTION	U.S.:	VOLATILE ORGANIC VAPORS (ppm)		REMARKS
							PID		
-120.0	-120.00	5/12/21	10		SILT AND COBBLES AND CALICHE:	ML/GM	12.4		poor sample returns
-1215.0	-125.00	10/13/26	40		PEBBLES AND SILT: light brown (7.5YR6/4), little sand, coarse to very fine.	GW	13.6		no odor
-1210.0	-130.00	8/11/15	30		COBBLES AND PEBBLES AND SILT: little sand, coarse to very fine, very slightly damp.	GW	38.7		very sl. petroleum odor
-1205.0	-135.00	7/12/18	90		SILT AND CLAY: brown (7.5YR5/4), plastic, moist.	CL	102		no odor
-1200.0	-140.00	6/8/15	70		SILT AND CLAY: brown (7.5YR5/4), plastic, little pebbles, moist.	CL	23.7		no odor
-1195.0	-145.00	4/4/3	20		SAND AND GRAVEL: light grey (7.5YR6/3), fine to very coarse, and pebbles, cobbles, very slightly damp.	SW	7.0		no odor
-1190.0	-150.00	4/7/9	90		CALICHE: some silt and clay, brown (7.5YR5/4), plastic, some sand, fine to medium, very slightly damp.	--	53.3		no odor
-1185.0	-155.00	7/9/15	10		PEBBLES AND GRAVEL: sand, and silt.	GW	4.6		no odor, poor sample returns

# WILLIAMS AFB ST-12 BIOVENTING PILOT TEST

PROJECT NO: 726876 SITE NO: ST-12 BOREHOLE NO: MPA OF 5  
 DATE BEGAN: 9/26/96 DATE FINISHED: 9/26/96 PROJECT NAME: WILLIAMS AFB  
 DRILLER: LAYNE ENVIRONMENTAL SERVICES NORTH: UNKNOWN FIELD GEOLOGIST: L. DUDUS  
 GROUND SURFACE ELEV.: 1341 feet GWL DATE/TIME: N/A EAST: UNKNOWN  
 DRILLING METHOD: DUAL-WALL PERCUSSION HAMMER (9" OD) DRILL EQUIP: AP-1000 GWL DEPTH: N/A  
 CONTRACTOR: PARSONS ENGINEERING SCIENCE GWL EQUIP: N/A  
 CHECKED BY: A.J.S.

ELEV (FT)	DEPTH (FT)	BLOW COUNT	PERCENT RECOVERY	PROFILE	DESCRIPTION	U: S: S:	VOLATILE ORGANIC VAPORS (ppm)		REMARKS
							PID	PID	
-1180.0	-160.00	6/8/19	10		PEBBLES AND GRAVEL: and sand, and silt.	GW	8.5		no odor, poor returns
-1175.0	-165.00	9/13/18	100		SILT AND CLAY: dark brown (7.5YR4/4), moderately plastic, little gravel.	CL	1240		strong petroleum odor
-1170.0	-170.00	5/8/13	70		CALICHE AND PEBBLES: and sand, and silt, brown (7.5YR5/4), very slightly damp.	GW	1090		strong petroleum odor
-1165.0	-175.00	6/11/15	80		SAND: brown (7.5YR5/4), fine to very fine, some silt, some pebbles.	SM	280		very strong petro. odor
-1160.0	-180.00	-----	60		SILT AND CLAY: brown (7.5YR5/4), plastic, some sand, very fine to medium, some gravel and pebbles, moist.	ML/GM	380		very strong petro. odor
-1155.0	-185.00	5/8/14	50		SILT AND CLAY: brown (7.5YR5/4), plastic, some sand, very fine to medium, some gravel and pebbles, moist.	ML/GM	980		very strong petro. odor
-1150.0	-190.00	7/12/18	60		SILT AND CLAY: dark brown (7.5YR4/4), plastic, and pebbles, and gravel, moist.	ML/GM	1225		very strong petro. odor
-1145.0	-195.00	6/9/18	75		COBBLES AND PEBBLES AND GRAVEL: some silt and clay, brown (7.5YR5/4), moderately plastic.	GW	1120		strong petroleum odor
-1140.0	-200.00	3/10/13	40		COBBLES AND PEBBLES AND GRAVEL: some silt and clay, brown (7.5YR5/4), moderately plastic.	GW	858		strong petroleum odor bottom of borehole at 200' sample punched to 201.5

# WILLIAMS AFB ST-12 BIOVENTING PILOT TEST

PROJECT NO: 726876 SITE NO: SI-12 BOREHOLE NO: MPB PAGE 1 OF 5  
 DATE BEGAN: 9/30/96 DATE FINISHED: 9/30/96 PROJECT NAME: WILLIAMS AFB  
 DRILLER: LAYNE ENVIRONMENTAL SERVICES NORTH: UNKNOWN FIELD GEOLOGIST: L. DUDUS  
 GROUND SURFACE ELEV.: 1341 feet GWL DATE/TIME: N/A EAST: UNKNOWN  
 DRILLING METHOD: DUAL-WALL PERCUSSION HAMMER (9" OD) DRILL EQUIP: AP-1000 GWL DEPTH: N/A  
 CONTRACTOR: PARSONS ENGINEERING SCIENCE CHECKED BY: A.J.S.

ELEV (FT)	DEPTH (FT)	BLOW COUNT	PERCENT RECOVERY	P. PROFILE	DESCRIPTION	U. S. S.	VOLATILE ORGANIC VAPORS (ppm)		REMARKS
								PID	
-1340.0	0.00								
-1335.0	-5.00	3/4/16	60		SILT AND SAND: dark brown (7.5YR4/4), very fine to medium, very slightly damp.	SM	0.0		no odor
-1330.0	-10.00	9/12/16	90		SAND AND SILT: brown (7.5YR5/4), very fine to very coarse, some gravel, very slightly damp.	SM	0.0		no odor
-1325.0	-15.00	10/17/23	100		SILT AND CLAY: dark brown (7.5YR4/4), moderately plastic, damp. (bottom of shoe - sand, fine to medium, some silt)	ML	80.3		slight petroleum odor, bottom of shoe: moderate petroleum odor
-1320.0	-20.00	15/21/28	100		SAND AND SILT: light brown (7.5YR6/4), very fine, slightly damp.	SM	367		moderate petroleum/anaerobic odor
-1315.0	-25.00	17/20/34	100		SAND AND SILT: light brown (7.5YR6/4), very fine, very slightly damp.	SM	1260		strong petroleum odor
-1310.0	-30.00	25/50-6"	100		SILT: light brown (7.5YR6/4), some sand, very fine, very slightly damp.	ML	1100		strong petroleum odor
-1305.0	-35.00	12/16/28	80		SILT: light brown (7.5YR6/4), some sand, very fine, very slightly damp.	ML	588		strong petroleum odor
-1300.0	-40.00								

# WILLIAMS AFB ST-12 BIOVENTING PILOT TEST

PROJECT NO: 726876 SITE NO: ST-12 BOREHOLE NO: MPB OF 5  
 DATE BEGAN: 9/30/96 PROJECT NAME: WILLIAMS AFB  
 DRILLER: LAYNE ENVIRONMENTAL SERVICES DATE FINISHED: 9/30/96 FIELD GEOLOGIST: L. DUDUS  
 GROUND SURFACE ELEV.: 1341 feet NORTH: UNKNOWN EAST: UNKNOWN  
 DRILLING METHOD: DUAL-WALL PERCUSSION HAMMER (9" OD) GWL DATE/TIME: N/A GWL DEPTH: N/A  
 CONTRACTOR: PARSONS ENGINEERING SCIENCE DRILL EQUIP: AP-1000 GWL EQUIP: N/A  
 CHECKED BY: A.J.S.

ELEV (FT)	DEPTH (FT)	BLOW COUNT	PERCENT RECOVERY	PROFILE	DESCRIPTION	U.S. S:	VOLATILE ORGANIC VAPORS (ppm)	REMARKS
							PIO	
-1300.0	-40.00	18/26/38	80		SILT: brown (7.5YR5/3), very slightly damp.	ML	1400	strong petroleum odor
-1295.0	-45.00	17/20/29	70		CALICHE: some silt, dark brown (7.5YR4/4), very slightly damp.	--	980	strong petro. odor, sample is non-representative (NR) of cuttings observation
-1290.0	-50.00	20/31/45	40		SILT: brown (7.5YR5/3), some sand, very fine, very slightly damp.	ML	1422	strong petroleum odor
-1285.0	-55.00	15/18/23	33		CALICHE: light brown (7.5YR6/3), some silt, very slightly damp.	--	1200	strong petroleum odor, NR
-1280.0	-60.00	15/18/25	33		SILT AND CALICHE: light brown (7.5YR6/3), very slightly damp.	ML	1580	very strong petroleum odor
-1275.0	-65.00	9/17/18	70		SILT: brown (7.5YR5/4), little caliche, slightly damp.	ML	1100	strong petroleum odor
-1270.0	-70.00	8/26/35	80		SILT AND CALICHE: light brown (7.5YR6/4), dry.	ML	915	strong petroleum odor
-1265.0	-75.00	5/5/13	30		CALICHE: large pieces in sample tube, some pebbles, gravel, sand, fine to very coarse, damp.	GW	1300	strong petroleum odor, NR
-1260.0	-80.00							







# WILLIAMS AFB ST-12 BIOVENTING PILOT TEST

PROJECT NO: 726876 SITE NO: ST-12 BOREHOLE NO: MPB PAGE 4 OF 5  
 DATE BEGAN: 9/30/96 DATE FINISHED: 9/30/96 PROJECT NAME: WILLIAMS AFB  
 DRILLER: LAYNE ENVIRONMENTAL SERVICES NORTH: UNKNOWN FIELD GEOLOGIST: L. DUDUS  
 GROUND SURFACE ELEV.: 1341 feet GWL DATE/TIME: N/A EAST: UNKNOWN  
 DRILLING METHOD: DUAL-WALL PERCUSSION HAMMER (9" OD) DRILL EQUIP: AP-1000 GWL DEPTH: N/A  
 CONTRACTOR: PARSONS ENGINEERING SCIENCE GWL EQUIP: N/A  
 CHECKED BY: A.J.S.

CONTINUED FROM PREVIOUS PAGE									
ELEV (FT)	DEPTH (FT)	BLOW COUNT	PERCENT RECOVERY	PROFILE	DESCRIPTION	USCS:	VOLATILE ORGANIC VAPORS (ppm)	REMARKS	
-1220.0	-120.00	6/13/18	--	OO OO OO OO OO OO OO OO OO OO	COBBLES: some sand, light brown (7.5YR6/4), fine to medium, some silt, very slightly damp.	GM	190	no odor, NR	
-1215.0	-125.00	3/9/18	40	OO OO OO OO OO OO OO OO OO OO	COBBLES AND CALICHE: some sand, light brown (7.5YR6/4), fine to medium, some silt, very slightly damp.	GM	24.9	no odor, NR	
-1210.0	-130.00	4/11/16	40	TT TT TT TT TT TT TT TT TT TT	CALICHE: large pieces, some silt, some sand, very slightly damp.	--	35.9	slight petroleum odor, NR	
-1205.0	-135.00	3/7/10	60	TT TT TT TT TT TT TT TT TT TT	SILT: brown (7.5YR5/4), very slightly plastic, some sand, fine to medium, some caliche, damp.	ML	1400	strong petroleum odor	
-1200.0	-140.00	2/6/8	60	TT TT TT TT TT TT TT TT TT TT	SAND: dark brown (7.5YR4/2), fine to medium, some silt, some pebbles, some caliche, moist.	SP/SM	1552	very strong petroleum odor, NR	
-1195.0	-145.00	11/18/21	40	TT TT TT TT TT TT TT TT TT TT	PEBBLES AND COBBLES: no soil.	GW	1566	very strong petroleum odor	
-1190.0	-150.00	9/15/23	40	TT TT TT TT TT TT TT TT TT TT	COBBLES AND SAND: brown (7.5YR5/4), medium to very coarse, very slightly damp.	GW	1383	strong petroleum odor	
-1185.0	-155.00	8/13/25	20	TT TT TT TT TT TT TT TT TT TT	PEBBLES: some sand, brown (7.5YR5/4), medium to very coarse, some gravel, very slightly damp.	GW	1500	very strong petroleum odor	
	-160.00								

PAGE 5 OF 5

CHECKED BY: A.J.S.

-205.03-

# WILLIAMS AFB ST-12 BIOVENTING PILOT TEST

PROJECT NO: 726876 SITE NO: ST-12 BOREHOLE NO: MPC  
 DATE BEGAN: 9/23/96 DATE FINISHED: 9/23/96 PROJECT NAME: WILLIAMS AFB  
 DRILLER: LAYNE ENVIRONMENTAL SERVICES NORTH: UNKNOWN FIELD GEOLOGIST: L. DUDUS  
 GROUND SURFACE ELEV.: 1341 feet GWL DATE/TIME: N/A EAST: UNKNOWN  
 DRILLING METHOD: DUAL-WALL PERCUSSION HAMMER (9" OD) DRILL EQUIP: AP-1000 GWL DEPTH: N/A  
 CONTRACTOR: PARSONS ENGINEERING SCIENCE GWL EQUIP: N/A  
 CHECKED BY: A.J.S.

PAGE 1 OF 5

ELEV (FT)	DEPTH (FT)	BLOW COUNT	PERCENT RECOVERY	PROFILE	DESCRIPTION	USCS:	VOLATILE ORGANIC VAPORS (ppm)	REMARKS
							PIO	
1340.0	0.00							
1335.0	-5.00	43/50-4"	50		SILT: dark brown (7.5YR3/4), dense, very slightly damp.	ML	0.0	no odor
1330.0	-10.00	50-4"	30		SILT: brown (7.5YR5/4), some sand, very fine, some caliche, dry.	SM	0.0	no odor
1325.0	-15.00	16/50-4"	40		SAND AND SILT: strong brown (7.5YR5/6), very fine, very slightly damp.	SM	0.0	no odor
1320.0	-20.00	23/50-2"	66		SAND AND SILT: dark brown (7.5YR4/4), very fine, very slightly damp.	SM	0.0	no odor
1315.0	-25.00	25/30/50-4"	80		SILT AND SAND: brown (7.5YR5/4), very fine, very slightly damp.	ML	0.0	no odor
1310.0	-30.00	50-5"	50		SILT: brown (7.5YR5/4), some sand, very fine, very slightly damp.	ML	0.0	no odor
1305.0	-35.00	14/16/27	100		SAND: brown (7.5YR5/5), fine to very coarse, trace gravel, very slightly damp.	SW	0.0	no odor
	-40.00							



PAGE 3 OF 5

PROJECT NO: 726876 SITE NO: ST-12 BOREHOLE NO: MPC PROJECT NAME: WILLIAMS AFB  
DATE BEGAN: 9/23/96 DATE FINISHED: 9/23/96 FIELD GEOLOGIST: L. DUDUS  
DRILLER: LAYNE ENVIRONMENTAL SERVICES NORTH: UNKNOWN EAST: UNKNOWN  
GROUND SURFACE ELEV.: 1341 Feet GWL DATE/TIME: N/A GWL DEPTH: N/A  
DRILLING METHOD: DUAL-WALL PERCUSSION HAMMER (9" OD) DRILL EQUIP: AP-1000 GWL EQUIP: N/A  
CONTRACTOR: PARSONS ENGINEERING SCIENCE CHECKED BY: A. J. S.

ELEV (FT)		DEPTH (FT)	BLOW COUNT	PERCENT RECOVERY	PROFILE	DESCRIPTION	USCS	VOLATILE ORGANIC VAPORS (ppm)	REMARKS
1260.0	-80.00	14/50-2"	25			CALICHE AND GRAVEL: light brown (7.5YR6/4), bottom 2" sand, medium to very coarse, very slightly damp.	GM	4.1	no odor
1255.0	-85.00	7/31/45	80			SILT AND CLAY: light brown (7.5YR6/4), slightly plastic, little gravel (caliche pieces), very slightly damp.	ML/CL	81	very slight petroleum odor
1250.0	-90.00	14/50-4"	30			CALICHE AND SILT: caliche up to 2" thick, light brown (7.5YR6/4), little sand, very fine, very slightly damp.	ML	4.0	no odor
1245.0	-95.00	21/31/34	100			SILT: light brown (7.5YR6/4), little sand, very fine, some large pieces of caliche.	ML	55.4	very slight petroleum odor
1240.0	-100.00	21/35/50-4"	66			SILT: light brown (7.5YR6/4), little sand, very fine, very slightly damp.	ML	145	slight petroleum odor
1235.0	-105.00	6/10/14	66			SILT: brown (7.5YR5/4), some caliche up to 1.5" thick, very slightly damp.	ML	4.1	no odor
1230.0	-110.00	10/13/18	66			SILT: dark brown (7.5YR4/3), some caliche, moist.	ML	74	no odor
1225.0	-115.00	10/31/48	66			SILT AND CALICHE: brown (7.5YR5/3), caliche 2" thick.	ML	4.1	no odor

PAGE 4 OF 5

BOREHOLE NO:MPC

MPC

WILLIAMS AFB

WILLIAMS AFB

DATE FINISHED: 9/23/96

9/23/96

FIELD GEOLOGIST: L. DODDS

**NORTH: UNKNOWN**

UNKNOWN

GWL DATE/TIME: N/A

N/A

1950-1951

ALL EQUIP: AP-1000

GWL EQUIP: N/A

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11-11-11

CHECKED BY: A.J.

CHECKED BY: A.J.S.

**-160.00-**

PAGE 5 OF 5

PROJECT NO. 726876 SITE NO. SI-12 BOREHOLE NO. MPC PROJECT NAME: WILLIAMS AFB  
DATE BEGAN: 9/23/96 DATE FINISHED: 9/23/96 FIELD GEOLOGIST: L. DUDUS  
DRILLER: LATNE ENVIRONMENTAL SERVICES NORTH: UNKNOWN EAST: UNKNOWN  
GROUND SURFACE ELEV.: 1341 feet GWL DATE/TIME: N/A GWL DEPTH: N/A  
DRILLING METHOD: DUAL-WALL PERCUSSION HAMMER (9" OD) DRILL EQUIP: AP-1000 GWL EQUIP: N/A  
CONTRACTOR: PARSONS ENGINEERING SCIENCE CHECKED BY: A.J.S.

ELEV (FT)	DEPTH (FT)	BLOW COUNT	PERCENT RECOVERY	PROFILE	DESCRIPTION	U. S. S.	VOLATILE ORGANIC VAPORS (ppm)		REMARKS
							PID		
1180.0	-160.08	5/8/15	30		SILT AND CLAY: brown (7.5YR5/4), plastic, some cobble-size caliche.	ML/GM	9.3		no odor
1175.0	-165.00	7/14/36	50		SILT AND CLAY: brown (7.5YR5/4), plastic, some cobbles and cobble- size caliche.	ML/GM	4.6		no odor
1170.0	-170.00	17/20/21	60		SILT AND CLAY: brown (7.5YR5/4), plastic, some cobbles, moist.	ML/GM	200		strong petroleum odor (bottom of sample only)
1165.0	-175.00	14/18/27	60		SILT AND CLAY: brown (7.5YR5/4), plastic, moist.	ML	350		slight petroleum odor
1160.0	-180.00	11/22/52	40		SILT: light brown (7.5YR6/4), some cobbles and caliche.	ML/GM	530		moderate petroleum odor
1155.0	-185.00	7/11/21	60		COBBLES: 20-50 mm, some silt, brown (7.5YR5/4).	GM	546		moderate petroleum odor
1150.0	-190.00	11/19/34	60		SILT AND CLAY: brown (7.5YR5/4), plastic, moist, some cobbles.	ML/GM	340		moderate petroleum odor
1145.0	-195.00	8/12/18	30		COBBLES: up to 40 mm, some silt and clay, brown (7.5YR5/4), plastic, moist.	GM	500		moderate petroleum odor
1140.0	-200.00	10/15/25			COBBLES: some silt and clay, brown (7.5YR5/4), plastic, moist.	GM	350		moderate petroleum odor bottom of borehole at 200', sample punched to 201.5'

Project Number: BE-1260-04  
 Client: USAF (AFCEE)  
 Location: Williams AFB, Arizona  
 Property Owner: USAF  
 Elevation:  
 Coordinates:  
 Drilling Company: Layne Environmental Drilling Co.  
 Rig Type: AP1000  
 Drilling Method: Dual Wall Percussion Hammer  
 Drillers: D. Peterson  
 Date Begun: 9/13/96 Date Completed: 9/17/96

Inspector: Powers  
 Depth Reached: 242  
 Well Depth: 242  
 Auger Diameter:  
 Hole Diameter: 4" Dual-Phase Extraction Well  
 Sampler: Powers  
 Hammer/Fall: 100#/36"  
 Sheet: 1 Of: 9

## Groundwater Readings

Date: Time:  
 Depth to Water:

Depth (feet)	S L E E V E	Time Collected	Analytical Samples	SPT Blows Per 0.5'	% Rec	PID (ppm)	U S C S	Stratigraphy/Remarks	Profile
0.0									
-1.0									
-2.0									
-3.0									
-4.0									
-5.0									
-6.0	P			19 33 34	70	0		Dry Reddish Brown (5YR5/3) Silt, Little Fine to Medium Sand No Odor, No Stain	
-7.0							ML		
-8.0									
-9.0									
-10.0									
-11.0	P			16 32 34	75	0		Dry Reddish Brown (5YR4/4) Silt, Little Fine to Medium Sand No Odor, No Stain	
-12.0							ML		
-13.0									
-14.0									
-15.0									
-16.0	P			11 50/5"	70	0		Dry Yellowish Red (5YR4/6) Silt, Trace Fine to Medium Sand No Odor, No Stain	
-17.0							ML		
-18.0									
-19.0									
-20.0									
-21.0	P			20 50/5"	70	0		Dry Reddish Brown (5YR5/4) Silt, Little Fine to Medium Sand No Odor, No Stain	
-22.0							ML		
-23.0									
-24.0									
-25.0									
-26.0	P			12 50/5"	60	0		Dry Reddish Brown (5YR4/4) Silt, Little Fine to Medium Sand, Trace Fine to Coarse Gravel No Odor, No Stain	
-27.0							ML		
-28.0									
-29.0									
-30.0									

P Brass Sleeve Screened Utilizing PID  
 S Brass Sleeve Submitted for Analysis



Project Number: BE-1260-04  
 Client: USAF (AFCEE)  
 Location: Williams AFB, Arizona  
 Property Owner: USAF  
 Elevation:  
 Coordinates:  
 Drilling Company: Layne Environmental Drilling Co.  
 Rig Type: AP1000  
 Drilling Method: Dual Wall Percussion Hammer  
 Drillers: D. Peterson  
 Date Begun: 9/13/96 Date Completed: 9/17/96

Inspector: Powers  
 Depth Reached: 242'  
 Well Depth: 242'  
 Auger Diameter:  
 Hole Diameter: 4" Dual-Phase Extraction Well  
 Sampler: Powers  
 Hammer/Fall: 100#/36"  
 Sheet: 2 Of: 9

## Groundwater Readings

Date: Time:  
 Depth to Water:

Depth (feet)	S L E E V E	Time Collected	Analytical Samples	SPT Blows Per 0.5'	% Rec	PID (ppm)	U S C S	Stratigraphy/Remarks	Profile
-30.0				13	50	0		Moist Reddish Brown (5YR4/4) Silt, Little Fine to Medium Sand, Trace Fine to Coarse Gravel No Odor, No Stain	
-31.0	P			50/3"					
-32.0							ML		
-33.0									
-34.0									
-35.0									
-36.0	P	9:20	DPE-35	15	70	0		Moist Brown (7.5YR4/4) Fine to Coarse Sand, Little Fine to Medium Gravel No Odor, No Stain	
-37.0	S			24					
-38.0				50/2"			SW		
-39.0									
-40.0									
-41.0	P			15	60	0		Moist Brown (7.5YR4/4) Fine to Coarse Sand, Some Fine to Coarse Gravel No Odor, No Stain	
-42.0				50/4"					
-43.0							SW		
-44.0									
-45.0									
-46.0				12	30	0		Moist Brown (7.5YR5/4) Silt, Little Fine to Medium Gravel, Trace Fine to Medium Sand No Odor, No Stain	
-47.0	P			50/1"			ML		
-48.0									
-49.0									
-50.0									
-51.0	P			25	40	0		Moist Brown (7.5YR5/4) Fine to Coarse Sand, Some Silt, Some Fine to Coarse Gravel No Odor, No Stain	
-52.0				50/5"					
-53.0							SM		
-54.0									
-55.0									
-56.0	P	9:55	DPE-55	7	80	0		Moist Reddish Brown (5YR4/4) Silt, Little Clay, Trace Fine Gravel No Odor, No Stain	
-57.0	S			9					
-58.0				13			ML		
-59.0									
-60.0									

P Brass Sleeve Screened Utilizing PID  
 S Brass Sleeve Submitted for Analysis

Project Number: BE-1260-04  
 Client: USAF (AFCEE)  
 Location: Williams AFB, Arizona  
 Property Owner: USAF  
 Elevation: \_\_\_\_\_  
 Coordinates: \_\_\_\_\_  
 Drilling Company: Layne Environmental Drilling Co.  
 Rig Type: AP1000  
 Drilling Method: Dual Wall Percussion Hammer  
 Drillers: D. Peterson  
 Date Begun: 9/13/96 Date Completed: 9/17/96

Inspector: Powers  
 Depth Reached: 242  
 Well Depth: 242  
 Auger Diameter: \_\_\_\_\_  
 Hole Diameter: 4" Dual-Phase Extraction Well  
 Sampler: Powers  
 Hammer/Fall: 100#/36"  
 Sheet: 3 Of: 9

Groundwater Readings	
Date: _____	Time: _____
Depth to Water: _____	

Depth (feet)	S L E E V E	Time Collected	Analytical Samples	SPT Blows Per 0.5'	% Rec	PID (ppm)	U S C S	Stratigraphy/Remarks	Profile
-60.0				6				Moist Reddish Brown (5YR4/4) Silt, Little Clay, Trace Fine Gravel No Odor, No Stan	
-61.0	P			8	90	0			
-62.0				10					
-63.0							ML		
-64.0									
-65.0								Moist Reddish Brown (5YR4/4) Silt, Little Fine Sand, Little Fine to Medium Gravel, Trace Clay No Odor, No Stain	
-66.0	P			7	75	0			
-67.0				10					
-68.0				21			ML		
-69.0									
-70.0								Moist Yellowish Red (5YR4/6) Silt, Little Clay, Little Fine Sand No Odor, No Stain	
-71.0	P			3	80	0			
-72.0				4					
-73.0				10			ML		
-74.0									
-75.0								Moist Strong Brown (7.5YR4/6) Fine Sand Very Slight Petroleum Odor, No Stain	
-76.0	P	10:25	DPE-75	5	90	0			
-77.0	S			8					
-78.0				11			SP		
-79.0									
-80.0								Moist Brown (7.5YR4/4) Fine to Coarse Sand, Some Fine to Coarse Gravel Very Slight Petroleum Odor, No Stain	
-81.0				19	30	0			
-82.0	P			50/4*					
-83.0							SW		
-84.0									
-85.0								Moist Brown (7.5YR5/3) Clay, Trace Fine Gravel Caliche Cement Very Slight Petroleum Odor, No Stain	
-86.0	P			13	60	0			
-87.0				17					
-88.0				20			CL		
-89.0									
-90.0									

☐ Brass Sleeve Screened Utilizing PID  
☐ Brass Sleeve Submitted for Analysis

Project Number: BE-1260-04  
 Client: USAF (AFCEE)  
 Location: Williams AFB, Arizona  
 Property Owner: USAF  
 Elevation: \_\_\_\_\_  
 Coordinates: \_\_\_\_\_  
 Drilling Company: Layne Environmental Drilling Co.  
 Rig Type: AP1000  
 Drilling Method: Dual Wall Percussion Hammer  
 Drillers: D. Peterson  
 Date Begun: 9/13/96 Date Completed: 9/17/96

Inspector: Powers  
 Depth Reached: 242'  
 Well Depth: 242'  
 Auger Diameter: \_\_\_\_\_  
 Hole Diameter: 4" Dual-Phase Extraction Well  
 Sampler: Powers  
 Hammer/Fall: 100#/36"  
 Sheet: 4 Of: 9

Groundwater Readings	
Date: _____	Time: _____
Depth to Water: _____	

Depth (feet)	S L E E V E	Time Collected	Analytical Samples	SPT Blows Per 0.5'	% Rec	PID (ppm)	U S C S	Stratigraphy/Remarks	Profile
-90.0				6				Moist Light Brown (7.5YR6/4) Clay	
-91.0	P			50/5*	50	0		Caliche Cement	
-92.0							CL	No Odor, No Stain	
-93.0									
-94.0									
-95.0									
-96.0	P	11:05	DPE-95	7	100	0		Moist Strong Brown (7.5YR4/6) Fine to Coarse Sand, Trace Fine Gravel	
-97.0	S			9				Very Slight Petroleum Odor, No Stain	
-98.0				13			SW		
-99.0									
-100.0									
-101.0	P			6	90	0		Moist Strong Brown (7.5YR4/6) Silt and Fine Sand, Some Fine to Medium Gravel	
-102.0				10				Very Slight Petroleum Odor, No Stain	
-103.0				12			ML		
-104.0									
-105.0									
-106.0	P			5	80	0		Moist Brown (7.5YR5/3) Silt, Little Fine to Coarse Gravel	
-107.0				15				Slight Petroleum Odor, No Stain	
-108.0				19			ML		
-109.0									
-110.0									
-111.0	P			5	100	0		Moist Brown (7.5YR4/3) Silt, Little Medium Gravel	
-112.0				8				No Odor, No Stain	
-113.0				13			ML		
-114.0									
-115.0									
-116.0	P			5	20	0		Moist Brown (7.5YR4/3) Fine to Coarse Gravel, Some Fine to Coarse Sand	
-117.0				11				No Odor, No Stain	
-118.0				19			GW		
-119.0									
-120.0									

☐ P Brass Sleeve Screened Utilizing PID  
☐ S Brass Sleeve Submitted for Analysis

Project Number: BE-1260-04  
 Client: USAF (AFCEE)  
 Location: Williams AFB, Arizona  
 Property Owner: USAF  
 Elevation:  
 Coordinates:  
 Drilling Company: Layne Environmental Drilling Co.  
 Rig Type: AP1000  
 Drilling Method: Dual Wall Percussion Hammer  
 Drillers: D. Peterson  
 Date Begun: 9/13/96 Date Completed: 9/17/96

Inspector: Powers  
 Depth Reached: 242'  
 Well Depth: 242'  
 Auger Diameter:  
 Hole Diameter: 4" Dual-Phase Extraction Well  
 Sampler: Powers  
 Hammer/Fall: 100#/36"  
 Sheet: 5 Of: 8

## Groundwater Readings

Date: Time:  
 Depth to Water:

Depth (feet)	S L E E V E	Time Collected	Analytical Samples	SPT Blows Per 0.5'	% Rec	PID (ppm)	U S C S	Stratigraphy/Remarks	Profile
-120.0							GW		
-121.0	P	12:55	DPE-120	18 28 50/3"	50	0		Moist Brown (7.5YR5/4) Silt, Some Fine to Coarse Sand, Little Fine to Coarse Gravel No Odor, No Stain	
-122.0	S								
-123.0							ML		
-124.0									
-125.0									
-126.0	P			8 11 16	40	0		Moist Brown (7.5YR5/3) Silt, Little Fine Sand, Little Medium Gravel No Odor, No Stain	
-127.0									
-128.0							ML		
-129.0									
-130.0									
-131.0	P			7 11 19	40	0		Moist Brown (7.5YR5/3) Fine to Coarse Gravel, Some Silt, Little Fine Sand No Odor, No Stain	
-132.0									
-133.0							GM		
-134.0									
-135.0									
-136.0	P	13:25	DPE-135	7 12 21	100	0		Moist Strong Brown (7.5YR4/6) Silt, Some Clay, Little Fine Sand, Trace Fine to Coarse Gravel No Odor, No Stain	
-137.0	S								
-138.0							ML		
-139.0									
-140.0									
-141.0	P			10 10 12	60	0		Moist Strong Brown (7.5YR4/6) Fine to Coarse Sand, Some Silt, Little Fine to Coarse Gravel No Odor, No Stain	
-142.0									
-143.0							SM		
-144.0									
-145.0									
-146.0	P			9 11 15	25	0		Moist Fine to Coarse Gravel (color indistinct) with interstitial Clay and Fine to Coarse Sand No Odor, No Stain	
-147.0									
-148.0							GW		
-149.0									
-150.0									

☐ Brass Sleeve Screened Utilizing PID  
☐ Brass Sleeve Submitted for Analysis

Project Number: BE-1260-04  
 Client: USAF (AFCEE)  
 Location: Williams AFB, Arizona  
 Property Owner: USAF  
 Elevation:  
 Coordinates:  
 Drilling Company: Layne Environmental Drilling Co.  
 Rig Type: AP1000  
 Drilling Method: Dual Wall Percussion Hammer  
 Drillers: D. Peterson  
 Date Begun: 9/13/96 Date Completed: 9/17/96

Inspector: Powers  
 Depth Reached: 242'  
 Well Depth: 242'  
 Auger Diameter:  
 Hole Diameter: 4" Dual-Phase Extraction Well  
 Sampler: Powers  
 Hammer/Fall: 100#/36"  
 Sheet: 6 Of: 9

## Groundwater Readings

Date: Time:  
 Depth to Water:

Depth (feet)	S L E E V E	Time Collected	Analytical Samples	SPT Blows Per 0.5'	% Rec	PID (ppm)	U S C S	Stratigraphy/Remarks	Profile
-150.0									
-151.0	P			5	30	0		Moist Brown (7.5YR5/4) Fine to Coarse Gravel, interstitial Clay and Fine to Coarse Sand No Odor, No Stain	
-152.0				14			GC		
-153.0				18					
-154.0									
-155.0									
-156.0	P			11	30	0		Moist Fine to Coarse Gravel (color indistinct) interstitial Fine to Coarse Sand No Odor, No Stain	
-157.0				13			GW		
-158.0				19					
-159.0									
-160.0									
-161.0	P			9	25	0		Moist Strong Brown (7.5YR4/6) Fine to Coarse Gravel, interstitial Fine to Coarse Sand, Some Silt, Little Clay No Odor, No Stain	
-162.0				15			GM		
-163.0				20					
-164.0									
-165.0									
-166.0	P	7:50	DPE-165	7	60	1680		Moist Reddish Brown (5YR5/3) Clay, Some Silt, Little Fine to Coarse Gravel Petroleum Odor, No Stain	
-167.0	S			9			CL		
-168.0				11					
-169.0									
-170.0									
-171.0	P			4	40	1840		Moist Brown (7.5YR5/3) Clay, Some Silt, Little Fine Gravel Petroleum Odor, No Stain	
-172.0				6			CL		
-173.0				9					
-174.0									
-175.0									
-176.0	P			9	70	750		Moist Brown (7.5YR4/4) Fine Sand and Silt, Little Fine Gravel Petroleum Odor, No Stain	
-177.0				11			SM		
-178.0				13					
-179.0									
-180.0									

P Brass Sleeve Screened Utilizing PID  
 S Brass Sleeve Submitted for Analysis

Project Number: BE-1260-04  
 Client: USAF (AFCEE)  
 Location: Williams AFB, Arizona  
 Property Owner: USAF  
 Elevation:  
 Coordinates:  
 Drilling Company: Layne Environmental Drilling Co.  
 Rig Type: AP1000  
 Drilling Method: Dual Wall Percussion Hammer  
 Drillers: D. Peterson  
 Date Begun: 9/13/96 Date Completed: 9/17/96

Inspector: Powers  
 Depth Reached: 242  
 Well Depth: 242  
 Auger Diameter:  
 Hole Diameter: 4" Dual-Phase Extraction Well  
 Sampler: Powers  
 Hammer/Fall: 100#/36"  
 Sheet: 7 Of: 9

## Groundwater Readings

Date: Time:  
 Depth to Water:

Depth (feet)	S L E E V E	Time Collected	Analytical Samples	SPT Blows Per 0.5'	% Rec	PID (ppm)	U S C S	Stratigraphy/Remarks	Profile
-180.0							SM		
-181.0	P			9	30	0		Moist Fine to Medium Gravel (color indistinct), Little Fine to Coarse Sand	
-182.0				12				Slight Petroleum Odor, No Stain	
-183.0				14					
-184.0							GW		
-185.0				7				Moist Brown (7.5YR5/3) Fine to Coarse Sand and Medium Gravel	
-186.0	P	8:35	DPE-185	11	70	1840		Petroleum Odor, No Stain	
-187.0	S			14					
-188.0							SW		
-189.0									
-190.0									
-191.0	P			7	60	250		Moist Brown (7.5YR4/4) Clay, Little Fine Gravel, Trace Fine to Coarse Sand	
-192.0				10				Slight Petroleum Odor, No Stain	
-193.0				12			CL		
-194.0									
-195.0				7				Moist Brown (7.5YR5/4) Clay and Fine to Medium Gravel, Little Fine to Coarse Sand	
-196.0	P			13	75	0		Petroleum Odor, No Stain	
-197.0				14					
-198.0							CL		
-199.0									
-200.0									
-201.0	P			6	30	0		Moist Brown (7.5YR5/4) Fine to Medium Gravel, Some Clay, Little Fine to Medium Sand	
-202.0				9				No Odor, No Stain	
-203.0				11			GC		
-204.0									
-205.0									
-206.0	P			10	50	140		Moist Strong Brown (7.5YR4/6) Clay, Some Medium Gravel	
-207.0				12				Petroleum Odor, No Stain	
-208.0				13			CL		
-209.0									
-210.0									

P Brass Sleeve Screened Utilizing PID  
 S Brass Sleeve Submitted for Analysis



Project Number: BE-1260-04  
 Client: USAF (AFCEE)  
 Location: Williams AFB, Arizona  
 Property Owner: USAF  
 Elevation: \_\_\_\_\_  
 Coordinates: \_\_\_\_\_  
 Drilling Company: Layne Environmental Drilling Co.  
 Rig Type: AP1000  
 Drilling Method: Dual Wall Percussion Hammer  
 Drillers: D. Peterson  
 Date Begun: 9/13/96 Date Completed: 9/17/96

Inspector: Powers  
 Depth Reached: 242'  
 Well Depth: 242'  
 Auger Diameter: \_\_\_\_\_  
 Hole Diameter: 4" Dual-Phase Extraction Well  
 Sampler: Powers  
 Hammer/Fall: 100#/36"  
 Sheet: 8 Of: 9

Groundwater Readings  
 Date: \_\_\_\_\_ Time: \_\_\_\_\_  
 Depth to Water: \_\_\_\_\_

Depth (feet)	S L E E V E	Time Collected	Analytical Samples	SPT Blows Per 0.5'	% Rec	PID (ppm)	U S C S	Stratigraphy/Remarks	Profile
-210.0		9:40	DPE-210	7	70	106	CL	Moist Strong Brown (7.5YR4/6) Clay, Some Medium Gravel Petroleum Odor, No Stain	
-211.0	P			10					
-212.0	S			12					
-213.0									
-214.0									
-215.0				7	0	0	SW	Wet Strong Brown (7.5YR4/6) Fine to Coarse Sand, Some Fine to Coarse Gravel (described from cuttings and shoe) No Odor, No Stain	
-216.0				8					
-217.0				9					
-218.0									
-219.0									
-220.0				6	25	220	GW	Wet Strong Brown (7.5YR4/6) Fine to Coarse Gravel, Some Fine to Coarse Sand Strong Petroleum Odor, No Stain	
-221.0	P			8					
-222.0				10					
-223.0									
-224.0									
-225.0				8	30	0	CL	Moist Brown (7.5YR5/3) Clay, Trace Fine Sand, Trace Fine Gravel No Odor, No Stain	
-226.0	P			11					
-227.0				12					
-228.0									
-229.0									
-230.0				10	15	0	SP	Wet Dark Brown (7.5YR3/2) Fine Sand, Trace Medium to Coarse Sand No Odor, No Stain	
-231.0	P			13					
-232.0	S			14					
-233.0									
-234.0									
-235.0				5	60	0	SW	Wet Brown (7.5YR4/3) Fine to Coarse Sand No Odor, No Stain	
-236.0	P			11					
-237.0				16					
-238.0									
-239.0									
-240.0									

BEM SYSTEMS, INC.

## FIELD SOIL BORING LOG

BORHOLE NUMBER:

DPE-1

Project Number: BE-1260-04  
 Client: USAF (AFCEE)  
 Location: Williams AFB, Arizona  
 Property Owner: USAF  
 Elevation:  
 Coordinates:  
 Drilling Company: Layne Environmental Drilling Co.  
 Rig Type: AP1000  
 Drilling Method: Dual Wall Percussion Hammer  
 Drillers: D. Peterson  
 Date Begun: 9/13/96 Date Completed: 9/17/96

Inspector: Powers  
 Depth Reached: 242'  
 Well Depth: 242'  
 Auger Diameter:  
 Hole Diameter: 4" Dual-Phase Extraction Well  
 Sampler: Powers  
 Hammer/Fall: 100#/36"  
 Sheet: 9 Of: 9

## Groundwater Readings

Date: Time:  
 Depth to Water:

Depth (feet)	S L E E V E	Time Collected	Analytical Samples	SPT Blows Per 0.5'	% Rec	PID (ppm)	U S C S	Stratigraphy/Remarks	Profile
-240.0				11				Wet Brown (7.5YR4/3) Fine to Coarse Sand No Odor, No Stain	
-241.0	P			13	25	0	SW		
-242.0	S			15					
-242.0								Total Depth = 242' BGS	
-243.0									
-244.0									
-245.0									
-246.0									
-247.0									
-248.0									
-249.0									
-250.0									
-251.0									
-252.0									
-253.0									
-254.0									
-255.0									
-256.0									
-257.0									
-258.0									
-259.0									
-260.0									
-261.0									
-262.0									
-263.0									
-264.0									
-265.0									
-266.0									
-267.0									
-268.0									
-269.0									
-270.0									

P Brass Sleeve Screened Utilizing PID  
 S Brass Sleeve Submitted for Analysis



BEM SYSTEMS, INC.	FIELD SOIL BORING LOG	BORHOLE NUMBER:	MPBG-1
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Project Number: BE-1260-04  
 Client: USAF (AFCEE)  
 Location: Williams AFB, Arizona  
 Property Owner: USAF  
 Elevation:  
 Coordinates:  
 Drilling Company: Layne Environmental Drilling Co.  
 Rig Type: AP1000  
 Drilling Method: Dual Wall Percussion Hammer  
 Drillers: D. Peterson  
 Date Begun: 9/18/96 Date Completed: 9/23/96

Inspector: Powers  
 Depth Reached: 242'  
 Well Depth: 242'  
 Auger Diameter:  
 Hole Diameter: 10" Soil Vapor Monitoring Point (Background)  
 Sampler: Powers  
 Hammer/Fall: 100#/36"  
 Sheet: 1 Of: 7

Groundwater Readings  
 Date: Time:  
 Depth to Water:

Depth (feet)	SLEEVE	Time Collected	Analytical Samples	SPT Blows Per 0.5'	% Rec	PID (ppm)	U S C S	Stratigraphy/Remarks	Profile
0.0									
-1.0									
-2.0							ML		
-3.0									
-4.0									
-5.0									
-6.0	P			15 50/4*	30	0		Dry Brown (7.5YR5/4) Silt, Some Fine to Coarse Sand, Little Fine to Coarse Gravel No Odor, No Stain	
-7.0									
-8.0							ML		
-9.0									
-10.0									
-11.0	P			50/5*	25	0		Dry Light Brown (7.5YR6/4) Silt, Little Fine Sand Caliche Cement No Odor, No Stain	
-12.0									
-13.0									
-14.0							ML		
-15.0									
-16.0	P			50/6*	50	0		Dry Strong Brown (7.5YR4/6) Fine to Medium Sand, Some Silt Caliche Cement No Odor, No Stain	
-17.0									
-18.0							SM		
-19.0									
-20.0									
-21.0	P			50/6*	30	0		Dry Strong Brown(7.5YR4/6) Fine to Medium Sand, Some Silt, Trace Coarse Gravel Caliche Cement No Odor, No Stain	
-22.0									
-23.0							SM		
-24.0									
-25.0									
-26.0	P S	10:20	BG-25	41 50/3*	35	0		Dry Brown (7.5YR5/4) Silt, Some Fine to Medium Sand, Caliche Cement No Odor, No Stain	
-27.0									
-28.0							ML		
-29.0									
-30.0									

☐ Brass Sleeve Screened Utilizing PID  
☐ Brass Sleeve Submitted for Analysis

Project Number: BE-1260-04  
 Client: USAF (AFCEE)  
 Location: Williams AFB, Arizona  
 Property Owner: USAF  
 Elevation: \_\_\_\_\_  
 Coordinates: \_\_\_\_\_  
 Drilling Company: Layne Environmental Drilling Co.  
 Rig Type: AP1000  
 Drilling Method: Dual Wall Percussion Hammer  
 Drillers: D. Peterson  
 Date Begun: 9/18/96 Date Completed: 9/23/96

Inspector: Powers  
 Depth Reached: 242'  
 Well Depth: 242'  
 Auger Diameter: \_\_\_\_\_  
 Hole Diameter: 10" Soil Vapor Monitoring Point (Background)  
 Sampler: Powers  
 Hammer/Fall: 100#/36"  
 Sheet: 2 Of: 7

Groundwater Readings	
Date: _____	Time: _____
Depth to Water: _____	

Depth (feet)	S L E E V E	Time Collected	Analytical Samples	SPT Blows Per 0.5'	% Rec	PID (ppm)	U S C S	Stratigraphy/Remarks	Profile
-30.0				9				Moist Strong Brown (7.5YR4/6) Silt, Some Fine to Medium Sand No Odor, No Stain	
-31.0	P			25	70	0			
-32.0				30			ML		
-33.0									
-34.0									
-35.0									
-36.0	P			17				Moist Brown (7.5YR4/3) Fine Sand No Odor, No Stain	
-37.0				38	100	0			
-38.0				41			SP		
-39.0									
-40.0									
-41.0	P			15				Moist Brown (7.5YR4/3) Fine to Coarse Sand, Trace Fine to Coarse Gravel No Odor, No Stain	
-42.0				20	80	0			
-43.0				23					
-44.0							SW		
-45.0									
-46.0	P			18				Moist Brown (7.5YR5/4) Fine to Coarse Gravel, Little Fine to Coarse Sand No Odor, No Stain	
-47.0				50/4"	40	0			
-48.0							GW		
-49.0									
-50.0									
-51.0	P	11:00	BG-50	12				Moist Strong Brown (7.5YR4/6) Silt, Some Fine to Coarse Sand and Fine to Medium Gravel No Odor, No Stain	
-52.0	S			50/5"	50	0			
-53.0								ML	
-54.0									
-55.0									
-56.0	P			16				Dry Light Brown (7.5YR6/4) Silt, trace Medium Gravel Caliche Cement No Odor, No Stain	
-57.0				25	50	0			
-58.0				35					
-59.0							ML		
-60.0									

☐ P Brass Sleeve Screened Utilizing PID  
☐ S Brass Sleeve Submitted for Analysis

Project Number:	BE-1260-04
Client:	USAF (AFCEE)
Location:	Williams AFB, Arizona
Property Owner:	USAF
Elevation:	
Coordinates	
Drilling Company:	Layne Environmental Drilling Co.
Rig Type:	AP1000
Drilling Method:	Dual Wall Percussion Hammer
Drillers	D. Peterson
Date Begun:	9/18/96
	Date Completed: 9/23/96

Inspector:	Powers
Depth Reached:	242'
Well Depth:	242'
Auger Diameter:	
Hole Diameter:	10" Soil Vapor Monitoring Point (Background)
Sampler:	Powers
Hammer/Fall:	100#/36"
Sheet:	3
Of:	7

Groundwater Readings	
Date:	Time:
Depth to Water:	

Depth (feet)	S L E V E	Time Collected	Analytical Samples	SPT Blows Per 0.5'	% Rec	PID (ppm)	U S C S	Stratigraphy/Remarks	Profile
-60.0				27	60	0		Dry Light Brown (7.5YR6/3) Silt, Little Fine Sand, Trace Fine to Coarse Gravel Caliche Cement No Odor, No Stain	
-61.0	P			50/4"					
-62.0									
-63.0							ML		
-64.0									
-65.0				7				Moist Brown (7.5YR5/4) Silt, Little Fine Sand, Trace Fine Gravel No Odor, No Stain	
-66.0	P			12	100	0			
-67.0				14					
-68.0							ML		
-69.0									
-70.0				12				Moist Brown (7.5YR5/3) Silt, Some Fine Sand, Little Fine to Medium Gravel No Odor, No Stain	
-71.0	P			50/5"	80	0			
-72.0									
-73.0							ML		
-74.0									
-75.0				26				Moist Reddish Brown (5YR4/4) Silt, Little Fine Gravel No Odor, No Stain	
-76.0	P	12:35	BG-75	38	90	0			
-77.0	S			40					
-78.0							ML		
-79.0									
-80.0				14				As Above	
-81.0	P			21	80	0		No Odor, No Stain	
-82.0				32					
-83.0							ML		
-84.0									
-85.0				11				Moist Reddish Brown (5YR4/4) Silt, Little Fine Gravel	
-86.0	P			16	95	0		Caliche Cement No Odor, No Stain	
-87.0				24					
-88.0							ML		
-89.0									
-90.0									

P	Brass Sleeve Screened Utilizing PID
S	Brass Sleeve Submitted for Analysis

Project Number: BE-1260-04  
 Client: USAF (AFCEE)  
 Location: Williams AFB, Arizona  
 Property Owner: USAF  
 Elevation:  
 Coordinates:  
 Drilling Company: Layne Environmental Drilling Co.  
 Rig Type: AP1000  
 Drilling Method: Dual Wall Percussion Hammer  
 Drillers: D. Peterson  
 Date Begun: 9/18/96 Date Completed: 9/23/96

Inspector: Powers  
 Depth Reached: 242'  
 Well Depth: 242'  
 Auger Diameter:  
 Hole Diameter: 10" Soil Vapor Monitoring Point (Background)  
 Sampler: Powers  
 Hammer/Fall: 100#/36"  
 Sheet: 4 Of: 7

## Groundwater Readings

Date: Time:  
 Depth to Water:

Depth (feet)	S L E E V E	Time Collected	Analytical Samples	SPT Blows Per 0.5'	% Rec	PID (ppm)	U S C S	Stratigraphy/Remarks	Profile
-90.0				8				Moist Reddish Brown (5YR4/4) Silt, Little Fine Gravel	
-91.0	P			11	80	0		Caliche Cement	
-92.0				15				No Odor, No Stain	
-93.0							ML		
-94.0									
-95.0				8				Moist Brown (7.5YR4/4) Fine to Coarse Sand (described from cuttings)	
-96.0	S	13:05	BG-95	12	60			Insufficient sample to screen with PID	
-97.0				13				No Odor, No Stain	
-98.0							SW		
-99.0									
-100.0				10				Moist Brown (7.5YR4/4) Silt, Some Fine Sand, Little Coarse Gravel	
-101.0	P			14	80	0		Caliche Cement	
-102.0				18				No Odor, No Stain	
-103.0							ML		
-104.0									
-105.0				9				Moist Brown (7.5YR4/4) Silt, Some Fine Sand	
-106.0	P			13	70	0		Caliche Cement	
-107.0				18				No Odor, No Stain	
-108.0							ML		
-109.0									
-110.0				11				Moist Brown (7.5YR4/3) Fine Sand, Some Silt, Little Fine to Coarse	
-111.0	P			13	80	0		Gravel	
-112.0				19				No Odor, No Stain	
-113.0							SM		
-114.0									
-115.0				10				Moist Brown (7.5YR4/4) Fine to Coarse Sand, Some Silt, Little Fine to	
-116.0	P			15	40	0		Coarse Gravel	
-117.0				17				No Odor, No Stain	
-118.0							SM		
-119.0									
-120.0									

P

Brass Sleeve Screened Utilizing PID

S

Brass Sleeve Submitted for Analysis

Project Number: BE-1260-04  
 Client: USAF (AFCEE)  
 Location: Williams AFB, Arizona  
 Property Owner: USAF  
 Elevation:  
 Coordinates:  
 Drilling Company: Layne Environmental Drilling Co.  
 Rig Type: AP1000  
 Drilling Method: Dual Wall Percussion Hammer  
 Drillers: D. Peterson  
 Date Begun: 9/18/96

Inspector: Powers  
 Depth Reached: 242'  
 Well Depth: 242'  
 Auger Diameter:  
 Hole Diameter: 10" Soil Vapor Monitoring Point (Background)  
 Sampler: Powers  
 Hammer/Fall: 100#/36"  
 Sheet: 5 Of: 7

## Groundwater Readings

Date: Time:  
 Depth to Water:

Depth (feet)	S L E V E	Time Collected	Analytical Samples	SPT Blows Per 0.5'	% Rec	PID (ppm)	U S C S	Stratigraphy/Remarks	Profile
-120.0							SM		
-121.0	P			8 10 12	40	0		Moist Brown (7.5YR5/3) Silt, Little Fine Sand, Trace Fine to Coarse Gravel No Odor, No Stain	
-122.0									
-123.0							ML		
-124.0									
-125.0									
-126.0	P			9 14 19	25	0		Moist Brown (7.5YR4/4) Silt Caliche Cement No Odor, No Stain	
-127.0									
-128.0							ML		
-129.0									
-130.0									
-131.0	P S	14:15	BG-130	10 13 16	60	0		Moist Brown (7.5YR5/3) Silt and Clay Caliche Cement No Odor, No Stain	
-132.0									
-133.0							ML		
-134.0									
-135.0									
-136.0	P			11 14 15	60	0		Moist Strong Brown (7.5YR4/6) Clay, Some Silt, Trace Fine to Coarse Sand No Odor, No Stain	
-137.0									
-138.0							CL		
-139.0									
-140.0									
-141.0	P			12 16 21	60	0		Moist Brown (7.5YR5/4) Fine to Coarse Gravel, interstitial Silt with Fine to Coarse Sand No Odor, No Stain	
-142.0									
-143.0							GM		
-144.0									
-145.0									
-146.0	P			10 12 13	30	0		Moist Brown (7.5YR4/4) Fine to Coarse Gravel, interstitial Fine to Coarse Sand, Little Clay No Odor, No Stain	
-147.0									
-148.0							GC		
-149.0									
-150.0									

P Brass Sleeve Screened Utilizing PID  
 S Brass Sleeve Submitted for Analysis

Project Number: BE-1260-04  
 Client: USAF (AFCEE)  
 Location: Williams AFB, Arizona  
 Property Owner: USAF  
 Elevation: \_\_\_\_\_  
 Coordinates: \_\_\_\_\_  
 Drilling Company: Layne Environmental Drilling Co.  
 Rig Type: AP1000  
 Drilling Method: Dual Wall Percussion Hammer  
 Drillers: D. Peterson  
 Date Begun: 9/18/96 Date Completed: 9/23/96

Inspector: Powers  
 Depth Reached: 242'  
 Well Depth: 242'  
 Auger Diameter: \_\_\_\_\_  
 Hole Diameter: 10" Soil Vapor Monitoring Point (Background)  
 Sampler: Powers  
 Hammer/Fall: 100#/36"  
 Sheet: 6 Of: 7

Groundwater Readings	
Date: _____	Time: _____
Depth to Water: _____	

Depth (feet)	S L E E V E	Time Collected	Analytical Samples	SPT Blows Per 0.5'	% Rec	PID (ppm)	U S C S	Stratigraphy/Remarks	Profile
-150.0		15:05	BG-155	16	50	0	GC	Moist Brown (7.5YR4/4) Fine to Coarse Gravel, interstitial Fine to Coarse Sand, Little Clay No Odor, No Stain	
-151.0	P			17					
-152.0				19					
-153.0									
-154.0									
-155.0				8	50	0	GC	As Above No Odor, No Stain	
-156.0	P			11					
-157.0	S			16					
-158.0									
-159.0									
-160.0				13	25	0	GC	As Above No Odor, No Stain	
-161.0	P			16					
-162.0				19					
-163.0									
-164.0									
-165.0		8	60	0	CL	Moist Reddish Brown (5YR4/3) Clay, Some Fine Sand, Little Fine Gravel No Odor, No Stain			
-166.0	P	13							
-167.0		14							
-168.0									
-169.0									
-170.0		10	80	0	CL	Moist Brown (7.5YR4/3) Clay, Some Fine Sand, Little Fine Gravel No Odor, No Stain			
-171.0	P	11							
-172.0		14							
-173.0									
-174.0									
-175.0		7:45	BG-175	10	30	0	GC	Moist Brown (7.5YR4/3) Fine to Coarse Gravel, interstitial Fine to Coarse Sand, Some Clay No Odor, No Stain	
-176.0	P			13					
-177.0	S			15					
-178.0									
-179.0									
-180.0									

☐ P Brass Sleeve Screened Utilizing PID  
☐ S Brass Sleeve Submitted for Analysis

BEM SYSTEMS, INC.

## FIELD SOIL BORING LOG

BORHOLE NUMBER:

MPBG-1

Project Number: BE-1260-04  
 Client: USAF (AFCEE)  
 Location: Williams AFB, Arizona  
 Property Owner: USAF  
 Elevation:  
 Coordinates:  
 Drilling Company: Layne Environmental Drilling Co.  
 Rig Type: AP1000  
 Drilling Method: Dual Wall Percussion Hammer  
 Drillers: D. Peterson  
 Date Begun: 9/18/96 Date Completed: 9/23/96

Inspector: Powers  
 Depth Reached: 242'  
 Well Depth: 242'  
 Auger Diameter:  
 Hole Diameter: 10" Soil Vapor Monitoring Point (Background)  
 Sampler: Powers  
 Hammer/Fall: 100#/36"  
 Sheet: 7 Of: 7

Groundwater Readings  
 Date: Time:  
 Depth to Water:

Depth (feet)	S L E E V E	Time Collected	Analytical Samples	SPT Blows Per 0.5'	% Rec	PID (ppm)	U S C S	Stratigraphy/Remarks	Profile
-180.0							GC		
-181.0				6				Moist Brown (7.5YR4/4) Clay, Little Fine to Coarse Gravel	
				10	30	0		No Odor, No Stain	
-182.0	P			12					
-183.0							CL		
-184.0									
-185.0									
-186.0				5				As Above	
				8	15	0		No Odor, No Stain	
-187.0	P			10					
-188.0							CL		
-189.0									
-190.0									
-191.0				6				As Above	
				7	15	0		No Odor, No Stain	
-192.0	P			10					
-193.0							CL		
-194.0									
-195.0									
-196.0				7				As Above	
				11	20	0		No Odor, No Stain	
-197.0	P			12					
-198.0							CL		
-199.0									
-200.0									
-201.0	P	8:35	BG-200	6				Moist Brown (7.5YR5/3) Clay, Some Fine to Coarse Gravel	
				12	90	0		No Odor, No Stain	
-202.0	S			11					
-203.0								Total Depth = 202' BGS	
-204.0									
-205.0									
-206.0									
-207.0									
-208.0									
-209.0									
-210.0									

P  
 S

Brass Sleeve Screened Utilizing PID

Brass Sleeve Submitted for Analysis

**APPENDIX C**

**LABORATORY ANALYTICAL RESULTS AND CHAIN-OF-  
CUSTODY FORMS**



# AIR TOXICS LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

RECEIVED

WORK ORDER #: 9610088

Work Order Summary

OCT 15 1996

PARSONS ENGINEERING  
SCIENCE, INC. - LA JOLLA

CLIENT:

Mr. Larry Dudas  
Parsons Engineering Science, Inc.  
9404 Genesee Avenue, Suite 140  
La Jolla, CA 92037

BILL TO: Mr. John Ratz

Parsons Engineering Science, Inc.  
1700 Broadway, Suite 900  
Denver, CO 80290

PHONE:

619-453-9650

FAX:

619-453-9652

DATE RECEIVED:

10/5/96

DATE COMPLETED:

10/10/96

INVOICE # 11985

P.O. # 726876.67130

PROJECT # 726876.67130 Extended Bioventing (WAFB)

AMOUNT\$: \$806.07


FRACTION #	NAME	TEST	RECEIPT	PRICE
			VAC/PRES.	
01A	WI-ST12-MPA-95	TO-3	3.0 "Hg	\$120.00
02A	WI-ST12-MPA-125	TO-3	2.5 "Hg	\$120.00
03A	WI-ST12-MPB-75	TO-3	2.5 "Hg	\$120.00
04A	WI-ST12-MPB-200	TO-3	2.5 "Hg	\$120.00
05A	WI-ST12-MPC-125	TO-3	3.0 "Hg	\$120.00
06A	WI-ST12-MPC-200	TO-3	3.0 "Hg	\$120.00
07A	Lab Blank	TO-3	NA	NC
07B	Lab Blank	TO-3	NA	NC

Misc. Charges

1 Liter Summa Canister Preparation (6) @ \$10.00 each.  
Shipping (9/4/96)

\$60.00  
\$26.07

CERTIFIED BY:

  
for Laboratory Director

DATE: 10/11/96

180 BLUE RAVINE ROAD, SUITE B FOLSOM, CA 95630  
(916) 985-1000 • (800) 985-5955 • FAX (916) 985-1020

# AIR TOXICS LTD.

SAMPLE NAME: WI-ST12-MPA-95

ID#: 9610088-01A

## EPA METHOD TO-3

(Aromatic Volatile Organics in Air)

### GC/PID

File Name:	6100815	Date of Collection: 10/3/96			
Dil. Factor:	2240	Date of Analysis: 10/8/96			
	Det. Limit	Det. Limit	Amount	Amount	
Compound	(ppmv)	(uG/L)	(ppmv)	(uG/L)	
Benzene	2.2	7.3	430	1400	
Toluene	2.2	8.6	430	1600	
Ethyl Benzene	2.2	9.9	33	140	
Total Xylenes	2.2	9.9	71	310	

### TOTAL PETROLEUM HYDROCARBONS

#### GC/FID

(Quantitated as Jet Fuel)

File Name: 6100815		Date of Collection: 10/3/96		
Dil. Factor: 2240		Date of Analysis: 10/8/96		
Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH* (C2+ Hydrocarbons)	22	150	42000	270000

\*TPH referenced to Jet Fuel (MW=156)

Container Type: 1 Liter Summa Canister

# AIR TOXICS LTD.

SAMPLE NAME: WI-ST12-MPA-125

ID#: 9610088-02A

## EPA METHOD TO-3

(Aromatic Volatile Organics in Air)

### GC/PID

<b>File Name:</b>	<b>6100819</b>	<b>Date of Collection:</b>	<b>10/3/96</b>	
<b>Dil. Factor:</b>	<b>2750</b>	<b>Date of Analysis:</b>	<b>10/8/96</b>	
<b>Compound</b>	<b>Det. Limit (ppmv)</b>	<b>Det. Limit (uG/L)</b>	<b>Amount (ppmv)</b>	<b>Amount (uG/L)</b>
Benzene	2.8	8.9	1000	3200
Toluene	2.8	11	1000	3800
Ethyl Benzene	2.8	12	70	310
Total Xylenes	2.8	12	210	930

### TOTAL PETROLEUM HYDROCARBONS

#### GC/FID

(Quantitated as Jet Fuel)

<b>File Name:</b>	<b>6100819</b>	<b>Date of Collection:</b>	<b>10/3/96</b>	
<b>Dil. Factor:</b>	<b>2750</b>	<b>Date of Analysis:</b>	<b>10/8/96</b>	
<b>Compound</b>	<b>Det. Limit (ppmv)</b>	<b>Det. Limit (uG/L)</b>	<b>Amount (ppmv)</b>	<b>Amount (uG/L)</b>
TPH* (C2+ Hydrocarbons)	28	180	120000	780000

\*TPH referenced to Jet Fuel (MW=156)

Container Type: 1 Liter Summa Canister

# AIR TOXICS LTD.

SAMPLE NAME: WI-ST12-MPB-75

ID#: 9610088-03A

## EPA METHOD TO-3

(Aromatic Volatile Organics in Air)

### GC/PID

File Name:	6100820	Date of Collection: 10/3/96		
Dil. Factor:	2200	Date of Analysis: 10/8/96		
	Det. Limit	Det. Limit	Amount	Amount
Compound	(ppmv)	(uG/L)	(ppmv)	(uG/L)
Benzene	2.2	7.1	440	1400
Toluene	2.2	8.4	580	2200
Ethyl Benzene	2.2	9.7	77	340
Total Xylenes	2.2	9.7	220	970

### TOTAL PETROLEUM HYDROCARBONS

#### GC/FID

(Quantitated as Jet Fuel)

File Name:	6100820	Date of Collection: 10/3/96			
Dil. Factor:	2200	Date of Analysis: 10/8/96			
	Det. Limit	Det. Limit	Amount	Amount	
Compound	(ppmv)	(uG/L)	(ppmv)	(uG/L)	
TPH* (C2+ Hydrocarbons)	22	140	54000	350000	

\*TPH referenced to Jet Fuel (MW=156)

Container Type: 1 Liter Summa Canister

# AIR TOXICS LTD.

SAMPLE NAME: WI-ST12-MPB-200

ID#: 9610088-04A

## EPA METHOD TO-3

(Aromatic Volatile Organics in Air)

### GC/PID

File Name:	6100821	Date of Collection: 10/3/96		
Dil. Factor:	2200	Date of Analysis: 10/8/96		
	Det. Limit	Det. Limit	Amount	Amount
Compound	(ppmv)	(uG/L)	(ppmv)	(uG/L)
Benzene	2.2	7.1	600	1900
Toluene	2.2	8.4	600	2300
Ethyl Benzene	2.2	9.7	70	310
Total Xylenes	2.2	9.7	160	710

### TOTAL PETROLEUM HYDROCARBONS

#### GC/FID

(Quantitated as Jet Fuel)

File Name:	6100821	Date of Collection: 10/3/96			
Dil. Factor:	2200	Date of Analysis: 10/8/96			
	Det. Limit	Det. Limit	Amount	Amount	
Compound	(ppmv)	(uG/L)	(ppmv)	(uG/L)	
TPH* (C2+ Hydrocarbons)	22	140	140000	910000	

\*TPH referenced to Jet Fuel (MW=156)

Container Type: 1 Liter Summa Canister

# AIR TOXICS LTD.

SAMPLE NAME: WI-ST12-MPC-125

ID#: 9610088-05A

## EPA METHOD TO-3

(Aromatic Volatile Organics in Air)

### GC/PID

<b>File Name:</b>	<b>6100905</b>	<b>Date of Collection:</b>	<b>10/3/96</b>	
<b>Dil. Factor:</b>	<b>2240</b>	<b>Date of Analysis:</b>	<b>10/9/96</b>	
<b>Compound</b>	<b>Det. Limit (ppmv)</b>	<b>Det. Limit (uG/L)</b>	<b>Amount (ppmv)</b>	<b>Amount (uG/L)</b>
Benzene	2.2	7.3	730	2400
Toluene	2.2	8.6	890	3400
Ethyl Benzene	2.2	9.9	60	260
Total Xylenes	2.2	9.9	180	790

### TOTAL PETROLEUM HYDROCARBONS

#### GC/FID

(Quantitated as Jet Fuel)

<b>File Name:</b>	<b>6100905</b>	<b>Date of Collection:</b>	<b>10/3/96</b>	
<b>Dil. Factor:</b>	<b>2240</b>	<b>Date of Analysis:</b>	<b>10/9/96</b>	
<b>Compound</b>	<b>Det. Limit (ppmv)</b>	<b>Det. Limit (uG/L)</b>	<b>Amount (ppmv)</b>	<b>Amount (uG/L)</b>
TPH* (C2+ Hydrocarbons)	22	150	97000	630000

\*TPH referenced to Jet Fuel (MW=156)

Container Type: 1 Liter Summa Canister

# AIR TOXICS LTD.

SAMPLE NAME: WI-ST12-MPC-200

ID#: 9610088-06A

## EPA METHOD TO-3

(Aromatic Volatile Organics in Air)

### GC/PID

<b>File Name:</b>	<b>6100907</b>	<b>Date of Collection: 10/3/96</b>		
<b>Dil. Factor:</b>	<b>5600</b>	<b>Date of Analysis: 10/9/96</b>		
	<b>Det. Limit</b>	<b>Det. Limit</b>	<b>Amount</b>	<b>Amount</b>
<b>Compound</b>	<b>(ppmv)</b>	<b>(uG/L)</b>	<b>(ppmv)</b>	<b>(uG/L)</b>
Benzene	5.6	18	1500	4900
Toluene	5.6	21	2000	7600
Ethyl Benzene	5.6	25	180	790
Total Xylenes	5.6	25	460	2000

### TOTAL PETROLEUM HYDROCARBONS

#### GC/FID

(Quantitated as Jet Fuel)

<b>File Name:</b>		<b>6100907</b>		<b>Date of Collection:</b> 10/3/96	
<b>Dil. Factor:</b>		<b>5600</b>		<b>Date of Analysis:</b> 10/9/96	
<b>Compound</b>	<b>Det. Limit (ppmv)</b>	<b>Det. Limit (uG/L)</b>	<b>Amount (ppmv)</b>	<b>Amount (uG/L)</b>	
TPH* (C2+ Hydrocarbons)	56	360	290000	1900000	

\*TPH referenced to Jet Fuel (MW=156)

Container Type: 1 Liter Summa Canister

# AIR TOXICS LTD.

SAMPLE NAME: Lab Blank

ID#: 9610088-07A

## EPA METHOD TO-3

(Aromatic Volatile Organics in Air)

### GC/PID

File Name:	6100811	Date of Collection: NA		
Dil. Factor:	1.00	Date of Analysis: 10/8/96		
	Det. Limit	Det. Limit	Amount	Amount
Compound	(ppmv)	(uG/L)	(ppmv)	(uG/L)
Benzene	0.001	0.003	Not Detected	Not Detected
Toluene	0.001	0.004	Not Detected	Not Detected
Ethyl Benzene	0.001	0.004	Not Detected	Not Detected
Total Xylenes	0.001	0.004	Not Detected	Not Detected

### TOTAL PETROLEUM HYDROCARBONS

#### GC/FID

(Quantitated as Jet Fuel)

File Name: 6100811		Date of Collection: NA		
Dil. Factor: 1.00		Date of Analysis: 10/8/96		
Compound	Det. Limit (ppmv)	Det. Limit (uG/L)	Amount (ppmv)	Amount (uG/L)
TPH* (C2+ Hydrocarbons)	0.010	0.065	Not Detected	Not Detected

\*TPH referenced to Jet Fuel (MW=156)

Container Type: NA



# AIR TOXICS LTD.

SAMPLE NAME: Lab Blank

ID#: 9610088-07B

## EPA METHOD TO-3

(Aromatic Volatile Organics in Air)

### GC/PID

<b>File Name:</b>	<b>6100904</b>	<b>Date of Collection:</b>	<b>NA</b>	
<b>Dil. Factor:</b>	<b>1.00</b>	<b>Date of Analysis:</b>	<b>10/9/96</b>	
<b>Compound</b>	<b>Det. Limit (ppmv)</b>	<b>Det. Limit (uG/L)</b>	<b>Amount (ppmv)</b>	<b>Amount (uG/L)</b>
Benzene	0.001	0.003	Not Detected	Not Detected
Toluene	0.001	0.004	Not Detected	Not Detected
Ethyl Benzene	0.001	0.004	Not Detected	Not Detected
Total Xylenes	0.001	0.004	Not Detected	Not Detected

### TOTAL PETROLEUM HYDROCARBONS

#### GC/FID

(Quantitated as Jet Fuel)

<b>File Name:</b>	<b>6100904</b>	<b>Date of Collection:</b>	<b>NA</b>	
<b>Dil. Factor:</b>	<b>1.00</b>	<b>Date of Analysis:</b>	<b>10/9/96</b>	
<b>Compound</b>	<b>Det. Limit (ppmv)</b>	<b>Det. Limit (uG/L)</b>	<b>Amount (ppmv)</b>	<b>Amount (uG/L)</b>
TPH* (C2+ Hydrocarbons)	0.010	0.065	Not Detected	Not Detected

\*TPH referenced to Jet Fuel (MW=156)

Container Type: NA



**AIR TOXICS LTD.**  
**AN ENVIRONMENTAL ANALYTICAL LABORATORY**

**180 BLUE RAVINE ROAD, SUITE B  
FOLSOM, CA 95630-4719  
(916) 985-1000 FAX: (916) 985-1020**

# CHAIN-OF-CUSTODY RECORD

963800

Page 7 of 7

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**Inchcape Testing Services**  
Environmental Laboratories

DATE RECEIVED: 25-Sep-1996

REPORT NUMBER: D96-10758  
REPORT DATE: 25-Sep-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science  
ADDRESS : 9404 Genesee #140  
La Jolla, CA 92037  
ATTENTION : Mr. Larry Dudas  
PROJECT : 726876.67130 Extended Biovent  
DATE SAMPLED : 24-Sep-1996

**RECEIVED**

OCT 30 1996

PARSONS ENGINEERING  
SCIENCE, INC. - LA JOLLA

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CASE NARRATIVE COMMENTS:

The bulk density, porosity and grain size analyses were performed at a sub-contracted Laboratory. The results are reported in the sub-contractors reporting format.

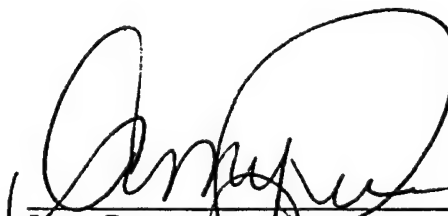
EPA 8020 analysis

Sample D96-10758-11

Due to matrix interference, toluene did not agree within  $\pm 50\%$  of the primary and confirmation columns. The lower result of the two columns was reported.

No further issues were noted during the sample analysis of this job.

If you have any questions, please call Ms. Jacqueline Mayhew at (214) 238-5591.

  
Amy Pence  
Data Review/QC



# Inchcape Testing Services

## NDRC Laboratories

1089 E. Collins Blvd.  
Richardson, TX 75081  
Tel. 214-238-5591  
Fax. 214-238-5592

### ANALYTICAL REPORT

DATE RECEIVED : 25-SEP-1996

REPORT NUMBER : D96-10758

REPORT DATE : 25-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science

ADDRESS : 9404 Genesee #140

: La Jolla, CA 92037

ATTENTION : Mr. Larry Dudus

PROJECT : 726876.67130 Extended Biovent.

Included in this data package are the analytical results for the sample group which you have submitted to Inchcape Testing Services for analysis. These results are representative of the samples as received by the laboratory.

The information contained herein has undergone extensive review and is deemed accurate and complete. Sample analysis and quality control were performed in accordance with all applicable protocols. Any deviations from these protocols or observations of interest are detailed in an accompanying Case Narrative. Please refrain from reproducing this report except in its entirety.

If you have any questions regarding this report and its associated materials please call your Project Manager at (214) 238-5591.

We appreciate the opportunity to serve you and look forward to providing continued service in the future.

Martin Jeffus  
General Manager



**Inchcape Testing Services**  
Environmental Laboratories

DATE RECEIVED : 25-SEP-1996

REPORT NUMBER : D96-10758-1

REPORT DATE : 25-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science  
ADDRESS : 9404 Genesee #140  
: La Jolla, CA 92037  
ATTENTION : Mr. Larry Dudas

SAMPLE MATRIX : Soil  
ID MARKS : W1-MPC-180'  
PROJECT : 726876.67130 Extended Biovent.  
DATE SAMPLED : 24-SEP-1996  
ANALYSIS METHOD : EPA 8020 /1  
ANALYZED BY : RFG  
ANALYZED ON : 2-OCT-1996  
DILUTION FACTOR : 100  
METHOD FACTOR : 1  
QC BATCH NO : 1002802001

BTEX ANALYSIS		
TEST REQUESTED	DETECTION LIMIT	RESULTS
Benzene	100 $\mu\text{g/Kg}$	240 $\mu\text{g/Kg}$
Toluene	200 $\mu\text{g/Kg}$	3240 $\mu\text{g/Kg}$
Ethyl benzene	200 $\mu\text{g/Kg}$	2750 $\mu\text{g/Kg}$
Xylenes	200 $\mu\text{g/Kg}$	15600 $\mu\text{g/Kg}$

QUALITY CONTROL DATA		
SURROGATE COMPOUND	SPIKE LEVEL	SPIKE RECOVERED
Bromofluorobenzene (SS)	50.0 $\mu\text{g/Kg}$	130 %



**Inchcape Testing Services**  
Environmental Laboratories

DATE RECEIVED : 25-SEP-1996

REPORT NUMBER : D96-10758-1

REPORT DATE : 25-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science

ADDRESS : 9404 Genesee #140

: La Jolla, CA 92037

ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Soil

ID MARKS : W1-MPC-180'

PROJECT : 726876.67130 Extended Biovent.

DATE SAMPLED : 24-SEP-1996

PREPARATION METHOD : EPA 3550A

PREPARED BY : PSS

PREPARED ON : 30-SEP-1996

ANALYSIS METHOD : EPA 8015M /1

ANALYZED BY : VHL

ANALYZED ON : 3-OCT-1996

DILUTION FACTOR : 1

METHOD FACTOR : 1

QC BATCH NO : 1002801501

TPH BY GC (EXTRACTABLE)		
TEST REQUESTED	DETECTION LIMIT	RESULTS
Total Petroleum Hydrocarbon	10.0 mg/Kg	168 mg/Kg

QUALITY CONTROL DATA		
SURROGATE COMPOUND	SPIKE LEVEL	SPIKE RECOVERED
Triacontane (SS)	100 mg/Kg	87.0 %



**Inchcape Testing Services**  
Environmental Laboratories

DATE RECEIVED : 25-SEP-1996

REPORT NUMBER : D96-10758-1

REPORT DATE : 25-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science  
ADDRESS : 9404 Genesee #140  
: La Jolla, CA 92037  
ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Soil  
ID MARKS : W1-MPC-180'  
PROJECT : 726876.67130 Extended Biovent.  
DATE SAMPLED : 24-SEP-1996

MISCELLANEOUS ANALYSES		
TEST REQUESTED	DETECTION LIMIT	RESULTS
Total Solids /1	0.01 %	87.3 %
Analyzed using ASTM D2216 mod. on 3-OCT-1996 by SAB QC Batch No : 1003221605		



DATE RECEIVED : 25-SEP-1996

REPORT NUMBER : D96-10758-2

REPORT DATE : 25-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science  
ADDRESS : 9404 Genesee #140  
: La Jolla, CA 92037  
ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Soil  
ID MARKS : W1-MPC-185'  
PROJECT : 726876.67130 Extended Biovent.  
DATE SAMPLED : 24-SEP-1996  
ANALYSIS METHOD : EPA 8020 /1  
ANALYZED BY : RFG  
ANALYZED ON : 2-OCT-1996  
DILUTION FACTOR : 25  
METHOD FACTOR : 1  
QC BATCH NO : 1002802001

BTEX ANALYSIS		
TEST REQUESTED	DETECTION LIMIT	RESULTS
Benzene	25 $\mu\text{g/Kg}$	67 $\mu\text{g/Kg}$
Toluene	50 $\mu\text{g/Kg}$	894 $\mu\text{g/Kg}$
Ethyl benzene	50 $\mu\text{g/Kg}$	1040 $\mu\text{g/Kg}$
Xylenes	50 $\mu\text{g/Kg}$	4450 $\mu\text{g/Kg}$

QUALITY CONTROL DATA		
SURROGATE COMPOUND	SPIKE LEVEL	SPIKE RECOVERED
Bromofluorobenzene (SS)	50.0 $\mu\text{g/Kg}$	127 %





**Inchcape Testing Services**  
Environmental Laboratories

DATE RECEIVED : 25-SEP-1996

REPORT NUMBER : D96-10758-2

REPORT DATE : 25-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science

ADDRESS : 9404 Genesee #140

: La Jolla, CA 92037

ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Soil

ID MARKS : W1-MPC-185'

PROJECT : 726876.67130 Extended Biovent.

DATE SAMPLED : 24-SEP-1996

PREPARATION METHOD : EPA 3550A

PREPARED BY : PSS

PREPARED ON : 30-SEP-1996

ANALYSIS METHOD : EPA 8015M /1

ANALYZED BY : VHL

ANALYZED ON : 3-OCT-1996

DILUTION FACTOR : 1

METHOD FACTOR : 1

QC BATCH NO : 1002801501

TPH BY GC (EXTRACTABLE)		
TEST REQUESTED	DETECTION LIMIT	RESULTS
Total Petroleum Hydrocarbon	10.0 mg/Kg	309 mg/Kg

QUALITY CONTROL DATA		
SURROGATE COMPOUND	SPIKE LEVEL	SPIKE RECOVERED
Triacontane (SS)	100 mg/Kg	94.7 %



**Inchcape Testing Services**  
Environmental Laboratories

DATE RECEIVED : 25-SEP-1996

REPORT NUMBER : D96-10758-2

REPORT DATE : 25-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science

ADDRESS : 9404 Genesee #140

: La Jolla, CA 92037

ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Soil

ID MARKS : W1-MPC-185'

PROJECT : 726876.67130 Extended Biovent.

DATE SAMPLED : 24-SEP-1996

MISCELLANEOUS ANALYSES		
TEST REQUESTED	DETECTION LIMIT	RESULTS
Total Solids /1	0.01 %	86.9 %
Analyzed using ASTM D2216 mod. on 3-OCT-1996 by SAB QC Batch No : 1003221605		



**Inchcape Testing Services**  
Environmental Laboratories

DATE RECEIVED : 25-SEP-1996

REPORT NUMBER : D96-10758-3

REPORT DATE : 25-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science  
ADDRESS : 9404 Genesee #140  
: La Jolla, CA 92037  
ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Soil  
ID MARKS : W1-MPC-175'  
PROJECT : 726876.67130 Extended Biovent.  
DATE SAMPLED : 24-SEP-1996

TOTAL METALS		
TEST REQUESTED	DETECTION LIMIT	RESULTS
Iron /1	10.0 mg/Kg	13500 mg/Kg
Dilution Factor : 1 Prepared using EPA 3051 on 2-OCT-1996 by CEL Analyzed using EPA 6010A on 24-OCT-1996 by GGD QC Batch No : 14845		



DATE RECEIVED : 25-SEP-1996

REPORT NUMBER : D96-10758-3

REPORT DATE : 25-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science

ADDRESS : 9404 Genesee #140

: La Jolla, CA 92037

ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Soil

ID MARKS : W1-MPC-175'

PROJECT : 726876.67130 Extended Biovent.

DATE SAMPLED : 24-SEP-1996

MISCELLANEOUS ANALYSES		
TEST REQUESTED	DETECTION LIMIT	RESULTS
Alkalinity /1	10.0 mg/KgCaCO3	200 mg/KgCaCO3
Analyzed using SM 2320B Mod. on 10-OCT-1996 by BAF QC Batch No : 1010232001		
Moisture (Oven) /1	0.01 %	18.2 %
Analyzed using ASTM D2216 Mod. on 1-OCT-1996 by RJS QC Batch No : 782029A		
Nitrogen, Total Kjeldahl /1	50.0 mg/Kg	126 mg/Kg
Dilution Factor : 1 Analyzed using EPA 351.3 on 2-OCT-1996 by BAF QC Batch No : 1002351301		
Total Phosphorus /1	5.0 mg/Kg	321 mg/Kg
Dilution Factor : 50 Analyzed using EPA 365.3 Mod. on 4-OCT-1996 by BAF QC Batch No : 1004365301		
pH /1		8.6 SU
Analyzed using EPA 9045 on 4-OCT-1996 by DPV QC Batch No : 830030		
Total Solids /1	0.01 %	81.9 %
Analyzed using ASTM D2216 mod. on 2-OCT-1996 by RJS QC Batch No : 782028A		



DATE RECEIVED : 25-SEP-1996

REPORT NUMBER : D96-10758-4

REPORT DATE : 25-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science

ADDRESS : 9404 Genesee #140

: La Jolla, CA 92037

ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Liquid

ID MARKS : Trip Blank

PROJECT : 726876.67130 Extended Biovent.

DATE SAMPLED : 24-SEP-1996

ANALYSIS METHOD : EPA 8020 /1

ANALYZED BY : VHT

ANALYZED ON : 1-OCT-1996

DILUTION FACTOR : 1

METHOD FACTOR : 1

QC BATCH NO : 1001802001

BTEX ANALYSIS		
TEST REQUESTED	DETECTION LIMIT	RESULTS
Benzene	1.0 µg/L	< 1.0 µg/L
Toluene	1.0 µg/L	< 1.0 µg/L
Ethyl benzene	1.0 µg/L	< 1.0 µg/L
Xylenes	1.0 µg/L	< 1.0 µg/L
BTEX (total)		< 1.0 µg/L #

QUALITY CONTROL DATA		
SURROGATE COMPOUND	SPIKE LEVEL	SPIKE RECOVERED
Bromofluorobenzene	50.0 µg/L	106 %

# Based upon Good Laboratory Practice, the result is rounded to the appropriate number of significant figures.



DATE RECEIVED : 25-SEP-1996

REPORT NUMBER : D96-10758-5

REPORT DATE : 25-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science

ADDRESS : 9404 Genesee #140

: La Jolla, CA 92037

ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Liquid

ID MARKS : Equipment Blank

PROJECT : 726876.67130 Extended Biovent.

DATE SAMPLED : 24-SEP-1996

ANALYSIS METHOD : EPA 8020 /1

ANALYZED BY : VHT

ANALYZED ON : 1-OCT-1996

DILUTION FACTOR : 1

METHOD FACTOR : 1

QC BATCH NO : 1001802001

BTEX ANALYSIS		
TEST REQUESTED	DETECTION LIMIT	RESULTS
Benzene	1.0 µg/L	< 1.0 µg/L
Toluene	1.0 µg/L	3.1 µg/L
Ethyl benzene	1.0 µg/L	< 1.0 µg/L
Xylenes	1.0 µg/L	< 1.0 µg/L
BTEX (total)		3.1 µg/L #

QUALITY CONTROL DATA		
SURROGATE COMPOUND	SPIKE LEVEL	SPIKE RECOVERED
Bromofluorobenzene	50.0 µg/L	105 %

# Based upon Good Laboratory Practice, the result is rounded to the appropriate number of significant figures.



**Inchcape Testing Services**  
Environmental Laboratories

DATE RECEIVED : 25-SEP-1996

REPORT NUMBER : D96-10758-5

REPORT DATE : 25-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science  
ADDRESS : 9404 Genesee #140  
: La Jolla, CA 92037  
ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Liquid  
ID MARKS : Equipment Blank  
PROJECT : 726876.67130 Extended Biovent.  
DATE SAMPLED : 24-SEP-1996  
PREPARATION METHOD : EPA 3510B  
PREPARED BY : TAP  
PREPARED ON : 1-OCT-1996  
ANALYSIS METHOD : EPA 8015M /1  
ANALYZED BY : VHL  
ANALYZED ON : 2-OCT-1996  
DILUTION FACTOR : 1  
METHOD FACTOR : 1  
QC BATCH NO : AB902-2

TPH BY GC (EXTRACTABLE)		
TEST REQUESTED	DETECTION LIMIT	RESULTS
Total Petroleum Hydrocarbon	0.50 mg/L	< 0.50 mg/L

QUALITY CONTROL DATA		
SURROGATE COMPOUND	SPIKE LEVEL	SPIKE RECOVERED
Triacontane (SS)	25.0 mg/L	84.8 %



**Inchcape Testing Services**  
Environmental Laboratories

DATE RECEIVED : 28-SEP-1996

REPORT NUMBER : D96-10758-6

REPORT DATE : 25-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science

ADDRESS : 9404 Genesee #140

: La Jolla, CA 92037

ATTENTION : Mr. Larry Dudas

SAMPLE MATRIX : Soil

ID MARKS : WI-ST12-MPA-100

PROJECT : 726876.67130 Extended Biovent.

DATE SAMPLED : 26-SEP-1996

TOTAL METALS		
TEST REQUESTED	DETECTION LIMIT	RESULTS
Iron /1	10.0 mg/Kg	11400 mg/Kg
Dilution Factor : 1 Prepared using EPA 3051 on 3-OCT-1996 by CEL Analyzed using EPA 6010A on 24-OCT-1996 by GGD QC Batch No : 14845		





**Inchcape Testing Services**  
Environmental Laboratories

DATE RECEIVED : 28-SEP-1996

REPORT NUMBER : D96-10758-6

REPORT DATE : 25-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science

ADDRESS : 9404 Genesee #140

: La Jolla, CA 92037

ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Soil

ID MARKS : WI-ST12-MPA-100

PROJECT : 726876.67130 Extended Biovent.

DATE SAMPLED : 26-SEP-1996

MISCELLANEOUS ANALYSES		
TEST REQUESTED	DETECTION LIMIT	RESULTS
Alkalinity /1	10.0 mg/KgCaCO3	250 mg/KgCaCO3
Analyzed using SM 2320B Mod. on 10-OCT-1996 by BAF QC Batch No : 1010232001		
Moisture (Oven) /1	0.01 %	15.2 %
Analyzed using ASTM D2216 Mod. on 1-OCT-1996 by RJS QC Batch No : 782029A		
Nitrogen, Total Kjeldahl /1	50.0 mg/Kg	70.0 mg/Kg
Dilution Factor : 1 Analyzed using EPA 351.3 on 11-OCT-1996 by BAF QC Batch No : 843035		
Total Phosphorus /1	10 mg/Kg	701 mg/Kg
Dilution Factor : 100 Analyzed using EPA 365.3 Mod. on 4-OCT-1996 by BAF QC Batch No : 1004365301		
pH /1		8.3 SU
Analyzed using EPA 9045 on 4-OCT-1996 by DPV QC Batch No : 830030		
Total Solids /1	0.01 %	84.8 %
Analyzed using ASTM D2216 mod. on 1-OCT-1996 by RJS QC Batch No : 782028A		



**Inchcape Testing Services**  
Environmental Laboratories

DATE RECEIVED : 28-SEP-1996

REPORT NUMBER : D96-10758-7

REPORT DATE : 25-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science  
ADDRESS : 9404 Genesee #140  
: La Jolla, CA 92037  
ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Soil  
ID MARKS : WI-ST12-MPA-165  
PROJECT : 726876.67130 Extended Biovent.  
DATE SAMPLED : 27-SEP-1996  
ANALYSIS METHOD : EPA 8020 /1  
ANALYZED BY : RFG  
ANALYZED ON : 2-OCT-1996  
DILUTION FACTOR : 50  
METHOD FACTOR : 1  
QC BATCH NO : 1002802001

BTEX ANALYSIS		
TEST REQUESTED	DETECTION LIMIT	RESULTS
Benzene	50 $\mu\text{g/Kg}$	764 $\mu\text{g/Kg}$
Toluene	100 $\mu\text{g/Kg}$	4440 $\mu\text{g/Kg}$
Ethyl benzene	100 $\mu\text{g/Kg}$	2900 $\mu\text{g/Kg}$
Xylenes	100 $\mu\text{g/Kg}$	9850 $\mu\text{g/Kg}$

QUALITY CONTROL DATA		
SURROGATE COMPOUND	SPIKE LEVEL	SPIKE RECOVERED
Bromofluorobenzene (SS)	50.0 $\mu\text{g/Kg}$	122 %



**Inchcape Testing Services**  
Environmental Laboratories

DATE RECEIVED : 28-SEP-1996

REPORT NUMBER : D96-10758-7

REPORT DATE : 25-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science  
ADDRESS : 9404 Genesee #140  
: La Jolla, CA 92037  
ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Soil  
ID MARKS : WI-ST12-MPA-165  
PROJECT : 726876.67130 Extended Biovent.  
DATE SAMPLED : 27-SEP-1996  
PREPARATION METHOD : EPA 3550A  
PREPARED BY : PSS  
PREPARED ON : 30-SEP-1996  
ANALYSIS METHOD : EPA 8015M /1  
ANALYZED BY : VHL  
ANALYZED ON : 3-OCT-1996  
DILUTION FACTOR : 1  
METHOD FACTOR : 1  
QC BATCH NO : 1002801501

TPH BY GC (EXTRACTABLE)		
TEST REQUESTED	DETECTION LIMIT	RESULTS
Total Petroleum Hydrocarbon	10.0 mg/Kg	223 mg/Kg

QUALITY CONTROL DATA		
SURROGATE COMPOUND	SPIKE LEVEL	SPIKE RECOVERED
Triacontane (SS)	100 mg/Kg	92.2 %



**Inchcape Testing Services**  
Environmental Laboratories

DATE RECEIVED : 28-SEP-1996

REPORT NUMBER : D96-10758-8

REPORT DATE : 25-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science

ADDRESS : 9404 Genesee #140

: La Jolla, CA 92037

ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Soil

ID MARKS : WI-ST12-MPA-175

PROJECT : 726876.67130 Extended Biovent.

DATE SAMPLED : 27-SEP-1996

ANALYSIS METHOD : ASTM D421/D422 /1

ANALYZED BY : KRH

ANALYZED ON : 10-OCT-1996

QC BATCH NO : 10596

GRADATION REPORT		
TEST REQUESTED	DETECTION LIMIT	RESULTS
Gravel & Coarse Sand (> 2.00 mm)	0.1 %	< 0.1 %
Medium & Fine Sand (0.075 to 2.00 mm)	0.1 %	47.5 %
Silt (0.005 to 0.075 mm)	0.1 %	35.5 %
Clay/Colloids (< 0.005 mm)	0.1 %	17.0 %



DATE RECEIVED : 28-SEP-1996

REPORT NUMBER : D96-10758-9

REPORT DATE : 25-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science

ADDRESS : 9404 Genesee #140

: La Jolla, CA 92037

ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Soil

ID MARKS : WI-ST12-MPA-190

PROJECT : 726876.67130 Extended Biovent.

DATE SAMPLED : 27-SEP-1996

ANALYSIS METHOD : EPA 8020 /1

ANALYZED BY : RFG

ANALYZED ON : 2-OCT-1996

DILUTION FACTOR : 500

METHOD FACTOR : 1

QC BATCH NO : 1002802001

BTEX ANALYSIS		
TEST REQUESTED	DETECTION LIMIT	RESULTS
Benzene	500 $\mu\text{g/Kg}$	3660 $\mu\text{g/Kg}$
Toluene	1000 $\mu\text{g/Kg}$	24300 $\mu\text{g/Kg}$
Ethyl benzene	1000 $\mu\text{g/Kg}$	15300 $\mu\text{g/Kg}$
Xylenes	1000 $\mu\text{g/Kg}$	35100 $\mu\text{g/Kg}$

QUALITY CONTROL DATA		
SURROGATE COMPOUND	SPIKE LEVEL	SPIKE RECOVERED
Bromofluorobenzene (SS)	50.0 $\mu\text{g/Kg}$	107 %



**Inchcape Testing Services**  
Environmental Laboratories

DATE RECEIVED : 28-SEP-1996

REPORT NUMBER : D96-10758-9

REPORT DATE : 25-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science

ADDRESS : 9404 Genesee #140

: La Jolla, CA 92037

ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Soil

ID MARKS : WI-ST12-MPA-190

PROJECT : 726876.67130 Extended Biovent.

DATE SAMPLED : 27-SEP-1996

PREPARATION METHOD : EPA 3550A

PREPARED BY : PSS

PREPARED ON : 30-SEP-1996

ANALYSIS METHOD : EPA 8015M /1

ANALYZED BY : VHL

ANALYZED ON : 3-OCT-1996

DILUTION FACTOR : 1

METHOD FACTOR : 1

QC BATCH NO : 1002801501

TPH BY GC (EXTRACTABLE)		
TEST REQUESTED	DETECTION LIMIT	RESULTS
Total Petroleum Hydrocarbon	10.0 mg/Kg	165 mg/Kg

QUALITY CONTROL DATA		
SURROGATE COMPOUND	SPIKE LEVEL	SPIKE RECOVERED
Triacontane (SS)	100 mg/Kg	83.6 %



**Inchcape Testing Services**  
Environmental Laboratories

DATE RECEIVED : 28-SEP-1996

REPORT NUMBER : D96-10758-9

REPORT DATE : 25-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science

ADDRESS : 9404 Genesee #140

: La Jolla, CA 92037

ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Soil

ID MARKS : WI-ST12-MPA-190

PROJECT : 726876.67130 Extended Biovent.

DATE SAMPLED : 27-SEP-1996

MISCELLANEOUS ANALYSES		
TEST REQUESTED	DETECTION LIMIT	RESULTS
Total Solids /1	0.01 %	79.8 %
Analyzed using ASTM D2216 mod. on 3-OCT-1996 by SAB QC Batch No : 1003221605		



DATE RECEIVED : 28-SEP-1996

REPORT NUMBER : D96-10758-10

REPORT DATE : 25-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science

ADDRESS : 9404 Genesee #140

: La Jolla, CA 92037

ATTENTION : Mr. Larry Dudas

SAMPLE MATRIX : Liquid

ID MARKS : Trip Blank

PROJECT : 726876.67130 Extended Biovent.

DATE SAMPLED : 27-SEP-1996

ANALYSIS METHOD : EPA 8020 /1

ANALYZED BY : VHT

ANALYZED ON : 1-OCT-1996

DILUTION FACTOR : 1

METHOD FACTOR : 1

QC BATCH NO : 1001802001

BTEX ANALYSIS		
TEST REQUESTED	DETECTION LIMIT	RESULTS
Benzene	1.0 µg/L	< 1.0 µg/L
Toluene	1.0 µg/L	< 1.0 µg/L
Ethyl benzene	1.0 µg/L	< 1.0 µg/L
Xylenes	1.0 µg/L	< 1.0 µg/L
BTEX (total)		< 1.0 µg/L #

QUALITY CONTROL DATA		
SURROGATE COMPOUND	SPIKE LEVEL	SPIKE RECOVERED
Bromofluorobenzene	50.0 µg/L	104 %

# Based upon Good Laboratory Practice, the result is rounded to the appropriate number of significant figures.





DATE RECEIVED : 28-SEP-1996

REPORT NUMBER : D96-10758-11

REPORT DATE : 25-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science  
ADDRESS : 9404 Genesee #140  
          : La Jolla, CA 92037  
ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Liquid  
ID MARKS : WI-ST12-MPA-EB  
PROJECT : 726876.67130 Extended Biovent.  
DATE SAMPLED : 27-SEP-1996  
ANALYSIS METHOD : EPA 8020 /1  
ANALYZED BY : VHT  
ANALYZED ON : 1-OCT-1996  
DILUTION FACTOR : 1  
METHOD FACTOR : 1  
QC BATCH NO : 1001802001

BTEX ANALYSIS		
TEST REQUESTED	DETECTION LIMIT	RESULTS
Benzene	1.0 µg/L	< 1.0 µg/L
Toluene	1.0 µg/L	1.3 µg/L
Ethyl benzene	1.0 µg/L	< 1.0 µg/L
Xylenes	1.0 µg/L	< 1.0 µg/L
BTEX (total)		1.3 µg/L #

QUALITY CONTROL DATA		
SURROGATE COMPOUND	SPIKE LEVEL	SPIKE RECOVERED
Bromofluorobenzene	50.0 µg/L	104 %

# Based upon Good Laboratory Practice, the result is rounded to the appropriate number of significant figures.



DATE RECEIVED : 28-SEP-1996

REPORT NUMBER : D96-10758-11

REPORT DATE : 25-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science

ADDRESS : 9404 Genesee #140

: La Jolla, CA 92037

ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Liquid

ID MARKS : WI-ST12-MPA-EB

PROJECT : 726876.67130 Extended Biovent.

DATE SAMPLED : 27-SEP-1996

PREPARATION METHOD : EPA 3510B

PREPARED BY : TAP

PREPARED ON : 1-OCT-1996

ANALYSIS METHOD : EPA 8015M /1

ANALYZED BY : VHL

ANALYZED ON : 2-OCT-1996

DILUTION FACTOR : 1

METHOD FACTOR : 1

QC BATCH NO : AB902-2

TPH BY GC (EXTRACTABLE)		
TEST REQUESTED	DETECTION LIMIT	RESULTS
Total Petroleum Hydrocarbon	0.50 mg/L	< 0.50 mg/L

QUALITY CONTROL DATA		
SURROGATE COMPOUND	SPIKE LEVEL	SPIKE RECOVERED
Triacontane (SS)	25.0 mg/L	85.2 %



**Inchcape Testing Services**  
Environmental Laboratories

DATE RECEIVED : 28-SEP-1996

REPORT NUMBER : D96-10758-12

REPORT DATE : 25-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science

ADDRESS : 9404 Genesee #140

: La Jolla, CA 92037

ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Soil

ID MARKS : Method Blank (Soil)

PROJECT : 726876.67130 Extended Biovent.

DATE SAMPLED : 28-SEP-1996

ANALYSIS METHOD : EPA 8020 /1

ANALYZED BY : RFG

ANALYZED ON : 2-OCT-1996

DILUTION FACTOR : 1

METHOD FACTOR : 1

QC BATCH NO : 1002802001

BTX ANALYSIS		
TEST REQUESTED	DETECTION LIMIT	RESULTS
Benzene	1.0 µg/Kg	< 1.0 µg/Kg
Toluene	2.0 µg/Kg	< 2.0 µg/Kg
Ethyl benzene	2.0 µg/Kg	< 2.0 µg/Kg
Xylenes	2.0 µg/Kg	< 2.0 µg/Kg

QUALITY CONTROL DATA		
SURROGATE COMPOUND	SPIKE LEVEL	SPIKE RECOVERED
Bromofluorobenzene (SS)	50.0 µg/Kg	101 %



**Inchcape Testing Services**  
Environmental Laboratories

DATE RECEIVED : 28-SEP-1996

REPORT NUMBER : D96-10758-13

REPORT DATE : 25-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science

ADDRESS : 9404 Genesee #140

: La Jolla, CA 92037

ATTENTION : Mr. Larry Dudas

SAMPLE MATRIX : Liquid

ID MARKS : Method Blank (Liquid)

PROJECT : 726876.67130 Extended Biovent.

DATE SAMPLED : 28-SEP-1996

ANALYSIS METHOD : EPA 8020 /1

ANALYZED BY : VHT

ANALYZED ON : 1-OCT-1996

DILUTION FACTOR : 1

METHOD FACTOR : 1

QC BATCH NO : 1001802001

BTEX ANALYSIS		
TEST REQUESTED	DETECTION LIMIT	RESULTS
Benzene	1.0 µg/L	< 1.0 µg/L
Toluene	1.0 µg/L	< 1.0 µg/L
Ethyl benzene	1.0 µg/L	< 1.0 µg/L
Xylenes	1.0 µg/L	< 1.0 µg/L
BTEX (total)		< 1.0 µg/L #

QUALITY CONTROL DATA		
SURROGATE COMPOUND	SPIKE LEVEL	SPIKE RECOVERED
Bromofluorobenzene	50.0 µg/L	108 %

# Based upon Good Laboratory Practice, the result is rounded to the appropriate number of significant figures.



REPORT DATE : 28-OCT-1996

REPORT NUMBER : D96-10758

SAMPLE SUBMITTED BY : Parsons Engineering Science  
ATTENTION : Mr. Larry Dudus

LABORATORY QUALITY CONTROL REPORT

ANALYTE	Benzene	Ethylbenzene	Toluene	m,p-Xylenes	o-Xylene
BATCH NO.	1001802001	1001802001	1001802001	1001802001	1001802001
LCS LOT NO.	AB709-51C	AB709-51C	AB709-51C	AB709-51C	AB709-51C
PREP METHOD	---	---	---	---	---
PREPARED BY	---	---	---	---	---
ANALYSIS METHOD	EPA 8020	EPA 8020	EPA 8020	EPA 8020	EPA 8020
ANALYZED BY	VHT	VHT	VHT	VHT	VHT
UNITS	µg/L	µg/L	µg/L	µg/L	µg/L
METHOD BLANK	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
SPIKE LEVEL	500	500	500	1000	500
SPK REC LIMITS	75.0 - 125	75.0 - 125	75.0 - 125	75.0 - 125	75.0 - 125
SPK RPD LIMITS	20.0	20.0	20.0	20.0	20.0
MS RESULT	510	542	539	1200	571
MS RECOVERY %	102	108	108	120	114
MSD RESULT	496	534	527	1190	561
MSD RECOVERY %	99.2	107	105	119	112
MS/MSD RPD %	2.78	1.49	2.25	0.84	1.77
BS RESULT	NA	NA	NA	NA	NA
BS RECOVERY %	NA	NA	NA	NA	NA
BSD RESULT	NA	NA	NA	NA	NA
BSD RECOVERY %	NA	NA	NA	NA	NA
BS/BSD RPD %	NA	NA	NA	NA	NA
DUP RPD LIMITS	---	---	---	---	---
DUPLICATE RPD %	NA	NA	NA	NA	NA
LCS LEVEL	50.0	50.0	50.0	100	50.0
LCS REC LIMITS	75.0 - 125	75.0 - 125	75.0 - 125	75.0 - 125	75.0 - 125
LCS RESULT	47.6	51.7	51.3	115	54.2
LCS RECOVERY %	95.2	103	103	115	108
SPIKE SAMPLE ID	10758-4	10758-4	10758-4	10758-4	10758-4
SAMPLE VALUE	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
DUP SAMPLE ID	---	---	---	---	---
DUP SAMPLE VAL/1	---	---	---	---	---
DUP SAMPLE VAL/2	---	---	---	---	---

NA Not applicable



REPORT DATE : 28-OCT-1996

REPORT NUMBER : D96-10758

SAMPLE SUBMITTED BY : Parsons Engineering Science  
ATTENTION : Mr. Larry Dudus

LABORATORY QUALITY CONTROL REPORT

ANALYTE	Benzene	Ethylbenzene	Toluene	m,p-Xylenes	o-Xylene
BATCH NO.	1002802001	1002802001	1002802001	1002802001	1002802001
LCS LOT NO.	AB709-51C	AB709-51C	AB709-51C	AB709-51C	AB709-51C
PREP METHOD	---	---	---	---	---
PREPARED BY	---	---	---	---	---
ANALYSIS METHOD	EPA 8020	EPA 8020	EPA 8020	EPA 8020	EPA 8020
ANALYZED BY	RFG	RFG	RFG	RFG	RFG
UNITS	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg
METHOD BLANK	< 1.00	< 2.00	< 2.00	< 2.00	< 2.00
SPIKE LEVEL	5000	5000	5000	10000	5000
SPK REC LIMITS	70.0 - 130	70.0 - 130	70.0 - 130	70.0 - 130	70.0 - 130
SPK RPD LIMITS	25.0	25.0	25.0	25.0	25.0
MS RESULT	6250	8500	9990	19700	8090
MS RECOVERY %	110	112	111	122	114
MSD RESULT	6170	8420	9950	19900	7730
MSD RECOVERY %	108	110	110	124	107
MS/MSD RPD %	1.47	1.44	0.72	1.62	6.52
BS RESULT	NA	NA	NA	NA	NA
BS RECOVERY %	NA	NA	NA	NA	NA
BSD RESULT	NA	NA	NA	NA	NA
BSD RECOVERY %	NA	NA	NA	NA	NA
BS/BSD RPD %	NA	NA	NA	NA	NA
DUP RPD LIMITS	---	---	---	---	---
DUPLICATE RPD %	NA	NA	NA	NA	NA
LCS LEVEL	50.0	50.0	50.0	100	50.0
LCS REC LIMITS	70.0 - 130	70.0 - 130	70.0 - 130	70.0 - 130	70.0 - 130
LCS RESULT	47.2	47.5	47.2	103	45.2
LCS RECOVERY %	94.4	95.0	94.4	103	90.4
SPIKE SAMPLE ID	10758-7	10758-7	10758-7	10758-7	10758-7
SAMPLE VALUE	764	2900	4440	7460	2390
DUP SAMPLE ID	---	---	---	---	---
DUP SAMPLE VAL/1	---	---	---	---	---
DUP SAMPLE VAL/2	---	---	---	---	---

NA

Not applicable



REPORT DATE : 28-OCT-1996

REPORT NUMBER : D96-10758

SAMPLE SUBMITTED BY : Parsons Engineering Science  
ATTENTION : Mr. Larry Dudas

LABORATORY QUALITY CONTROL REPORT

ANALYTE	Total Petroleum Hydrocarbon	Total Extractable Hydrocarbons	Iron	Alkalinity
BATCH NO.	AB902-2	1002801501	14845	1010232001
LCS LOT NO.	AB868-17	---	690619,690613	9971
PREP METHOD	EPA 3510B	EPA 3550A	EPA 3051	---
PREPARED BY	TAP	PSS	CEL	---
ANALYSIS METHOD	EPA 8015M	EPA 8015M	EPA 6010A	SM 2320B Mod.
ANALYZED BY	VHL	VHL	GGD	BAF
UNITS	mg/L	mg/Kg	mg/Kg	mg/Kg
METHOD BLANK	< 0.50	< 2.00	< 10.0	< 10.0
SPIKE LEVEL	5.00	83.3	100	4600
SPK REC LIMITS	35.0 - 115	51.0 - 153	60.0 - 140	90.0 - 110
SPK RPD LIMITS	25.0	50.0	30.0	35.0
MS RESULT	5.04	224	F	4300
MS RECOVERY %	101	21.6	F	88.0
MSD RESULT	4.98	167	F	4200
MSD RECOVERY %	99.6	46.8	F	85.9
MS/MSD RPD %	1.20	543	F	2.50
BS RESULT	NA	84.5	NA	NA
BS RECOVERY %	NA	101	NA	NA
BSD RESULT	NA	82.2	NA	NA
BSD RECOVERY %	NA	98.7	NA	NA
BS/BSD RPD %	NA	2.76	NA	NA
DUP RPD LIMITS	---	---	30.0	35.0
DUPLICATE RPD %	NA	NA	9.60	0.00
LCS LEVEL	2.50	---	100	174
LCS REC LIMITS	35.0 - 115	---	60.0 - 140	90.0 - 110
LCS RESULT	2.39	SEE_BS	118	182
LCS RECOVERY %	95.6	SEE_BS	118	105
SPIKE SAMPLE ID	10867-1	10838-11	10758-3	10758-6
SAMPLE VALUE	< 0.500	206	11400	250
DUP SAMPLE ID	---	---	10758-3	10758-6
DUP SAMPLE VAL/1	---	---	12600	250
DUP SAMPLE VAL/2	---	---	11400	250

NA  
SEE\_BS  
F

Not applicable  
LCS and LCS Duplicate reported as BS and BSD.  
Not applicable due to high analyte concentration in the QC sample.



REPORT DATE : 28-OCT-1996

REPORT NUMBER : D96-10758

SAMPLE SUBMITTED BY : Parsons Engineering Science

ATTENTION : Mr. Larry Dudas

LABORATORY QUALITY CONTROL REPORT

ANALYTE	Nitrogen, Total Kjeldahl	Nitrogen, Total Kjeldahl	Total Phosphorus	pH
BATCH NO.	843035	1002351301	1004365301	830030
LCS LOT NO.	9966	9966	9966	9971
PREP METHOD	---	---	---	---
PREPARED BY	---	---	---	---
ANALYSIS METHOD	EPA 351.3	EPA 351.3	EPA 365.3 Mod.	EPA 9045
ANALYZED BY	BAF	BAF	BAF	DPV
UNITS	mg/Kg	mg/Kg	mg/Kg	---
METHOD BLANK	<50	< 50.0	< 0.10	
SPIKE LEVEL	1000	1000	400	---
SPK REC LIMITS	85.0 - 115	85.0 - 115	80.0 - 120	---
SPK RPD LIMITS	20.0	20.0	20.0	---
MS RESULT	868	840	1030	NA
MS RECOVERY %	79.8	84.0	17.5 B	NA
MSD RESULT	910	882	1020	NA
MSD RECOVERY %	84.0	88.2	16.3 B	NA
MS/MSD RPD %	5.13	4.88	7.41 B	NA
BS RESULT	NA	NA	NA	NA
BS RECOVERY %	NA	NA	NA	NA
BSD RESULT	NA	NA	NA	NA
BSD RECOVERY %	NA	NA	NA	NA
BS/BSR RPD %	NA	NA	NA	NA
DUP RPD LIMITS	20.0	---	20.0	5.00
DUPLICATE RPD %	0.00	NC	0.84	1.12
LCS LEVEL	475	9.50	6.26	9.05
LCS REC LIMITS	85.0 - 125	85.0 - 125	80.0 - 120	95.0 - 105
LCS RESULT	462	8.96	6.20	9.20
LCS RECOVERY %	97.3	94.3	99.0	102
SPIKE SAMPLE ID	10758-6	10838-11	10838-11	---
SAMPLE VALUE	70.0	< 50.0	959	8.90
DUP SAMPLE ID	10758-6	10838-11	10838-11	11049-6
DUP SAMPLE VAL/1	70.0	---	951	9.00
DUP SAMPLE VAL/2	70.0	---	959	8.90

NA  
NC  
\_B

Not applicable  
Not calculable  
Not applicable due to matrix interference in the QC Sample.





# Inchcape Testing Services

Environmental Laboratories

55 South Park Drive  
Colchester, VT 05446

75 Green Mountain Drive  
South Burlington, VT 05403

## Analytical Report

Inchcape Testing Services  
Environmental Laboratories  
1089 East Collins Boulevard  
Richardson, TX 75081

Date : 10/09/96  
ETR Number : 61723  
Project No.: 96000  
No. Samples: 2  
Arrived : 10/02/96  
P.O. Number: 10296

Page 1

Standard analyses were performed in accordance with Methods for Analysis of Water and Wastes, EPA-600/4/79-020, Test Methods for Evaluating Solid Waste, SW-846, or Standard Methods for the Examination of Water and Wastewater. All results are in mg/l unless otherwise noted.

Lab No./ Method No.	Sample Description/ Parameter	Result
314934	D96-10758-8:09/27/96 @0835(Soil) REP 175	
	D2937 In-Place Density	C
	D854 Specific Gravity	C
	QSOA Porosity B1 Calculation	C
314934DP	D96-10758-8REP:[REP]09/27/96 @0835(Soil)	
	D2937 In-Place Density	C
	D854 Specific Gravity	C
	QSOA Porosity B1 Calculation	C

### Comments/Notes

C = Procedure/analysis completed

< Last Page >

Submitted By :

Aquatec Inc.

*R. Mason Nutter*



**ITS****Intertek Testing Services**  
Environmental Laboratories55 South Park Drive  
Colchester, VT 05446**Analytical Report****In-place Density by ASTM D 2937  
and  
Soil Moisture by ASTM D 2216  
Porosity by calculation**Client: NDRC  
ETR: 61723  
Job: ParsonsStart date: 4 Oct 96, RGF  
Final date: 6 Oct. 96 RGF  
Analyst: RGF, CJA\*

	1	2
Sample No.	314934	314934DP
Sample ID.	D96-10758-8	D96-10758-8REP
Sample Wet Wt. (grams)	398.52	398.52
Container/Sample Wt. (Wet)	610.60	610.60
Container Wt.	212.08	212.08
% Moisture (dry Mass basis)	19.9%	19.9%
Pan Wt.	398.52	398.52
Pan/Wet Wt.	332.29	332.29
Pan/Dry Wt.		
Sample Volume (cm <sup>3</sup> )	215.39	215.39
Sample Recovery	7.37	7.37
Container Diameter	6.10	6.10
Area	29.22	29.22
Dry Mass (grams)	332.29	332.29
In-place Density (g/cm <sup>3</sup> )	1.54	1.54
Specific Gravity	2.61	2.66
Porosity **	0.41	0.42

\* Porosity calculation corrected by CJA 3/26/97.

\*\* Porosity was calculated using the formula:  $n = 1 - (Pb/Ps)$  where  $n$  = porosity,  $Pb$  = density, and  $Ps$  = specific gravity.  
No. 315838 had large stones which created large voids.Submitted by: *Christy Anderson*Date: *16 April 97*

55 South Park Drive • Colchester, VT 05446 • Tel: 802-655-1203 • 802-655-1248

# COOLER RECEIPT FORM

Date Received: 9/28/96

Project: Bioventing 726876-67130

Date Logged-in: 9/28/96

Received by: L. D. May

1	Shipping slip. If yes, carrier and bill number: <u>FED EX 9751633220</u>	<input checked="" type="radio"/> Yes	<input type="radio"/> No
2	Custody seals on cooler. If yes, how many and where: <u>1 on front</u>	<input checked="" type="radio"/> Yes	<input type="radio"/> No
3	Custody seals intact.	<input checked="" type="radio"/> Yes	<input type="radio"/> No
4	Chain of Custody in plastic.	<input checked="" type="radio"/> Yes	<input type="radio"/> No
5	Chain of Custody filled out properly.	<input checked="" type="radio"/> Yes	<input type="radio"/> No
6	Client signed Chain of Custody.	<input checked="" type="radio"/> Yes	<input type="radio"/> No
7	Samples shipped on ice. If no, temperature of cooler:	<input checked="" type="radio"/> Yes	<input type="radio"/> No
8	All bottles sealed.	<input checked="" type="radio"/> Yes	<input type="radio"/> No <sup>am</sup> Brass Tubes
9	All bottles received intact.	<input checked="" type="radio"/> Yes	<input type="radio"/> No
10	Labels in good condition and complete.	<input checked="" type="radio"/> Yes	<input type="radio"/> No
11	Sample labels agree with Chain of Custody.	<input checked="" type="radio"/> Yes	<input type="radio"/> No
12	Correct containers used.	<input checked="" type="radio"/> Yes	<input type="radio"/> No
13	Correct preservative used.	<input checked="" type="radio"/> Yes	<input type="radio"/> No
14	Sufficient sample provided.	<input checked="" type="radio"/> Yes	<input type="radio"/> No
15	Bubbles absent from VOA.	<input checked="" type="radio"/> Yes	<input type="radio"/> No
16	Comments (use corrective action form if necessary): _____ _____ _____ _____ _____		

# COOLER RECEIPT FORM

Date Received: 9/25/96

Project: 726.876-67130

Date Logged-in: 9/25/96

Received by: [Signature]

1	Shipping slip. If yes, carrier and bill number: <u>FED EX 1933889381</u>	<input checked="" type="radio"/> Yes	<input type="radio"/> No
2	Custody seals on cooler. If yes, how many and where: <u>Front of cooler</u>	<input checked="" type="radio"/> Yes	<input type="radio"/> No
3	Custody seals intact.	<input checked="" type="radio"/> Yes	<input type="radio"/> No
4	Chain of Custody in plastic.	<input checked="" type="radio"/> Yes	<input type="radio"/> No
5	Chain of Custody filled out properly.	<input checked="" type="radio"/> Yes	<input type="radio"/> No
6	Client signed Chain of Custody.	<input checked="" type="radio"/> Yes	<input type="radio"/> No
7	Samples shipped on ice. If no, temperature of cooler:	<input checked="" type="radio"/> Yes	<input type="radio"/> No
8	All bottles sealed.	<input checked="" type="radio"/> Yes	<input checked="" type="radio"/> No
9	All bottles received intact.	<input checked="" type="radio"/> Yes	<input type="radio"/> No
10	Labels in good condition and complete.	<input checked="" type="radio"/> Yes	<input type="radio"/> No
11	Sample labels agree with Chain of Custody.	<input checked="" type="radio"/> Yes	<input type="radio"/> No
12	Correct containers used.	<input checked="" type="radio"/> Yes	<input type="radio"/> No
13	Correct preservative used.	<input checked="" type="radio"/> Yes	<input type="radio"/> No
14	Sufficient sample provided.	<input checked="" type="radio"/> Yes	<input type="radio"/> No
15	Bubbles absent from VOA.	<input checked="" type="radio"/> Yes	<input type="radio"/> No
16	Comments (use corrective action form if necessary): _____ _____ _____ _____ _____		

Brass sleeves were sealed

[illegible]

	WW - Wastewater 40 ml vial	W - Water A/G - Amber / Or Glass 1 Liter	S - Soil	SD - Solid	L - Liquid 250 ml - Glass wide mouth	A - Air Bag	C - Charcoal tube P/O - Plastic or other	SL - Sludge	O - Oil
1 Matrix									
2 Container									

**Inchcape cannot accept verbal changes.**  
**Please Fax written changes to**  
**214-238-5592**

Report to:				Invoice to				ANALYSIS REQUESTED		Lab use only	
Company: PARSONS ES				Company: SAME				Due Date:		Temp. of coolers when received (C°):	
Address: 9404 CIENESEEE 140				Address:						2 3 4 5	
Contact: LA JOLLA CA 92037				Contact:						Custody Seal N Y	
Phone: 619 453 9650				Phone:						Intact N Y	
Fax: 619 453 9652				PO/ISO #: 726876.67130						Screened For Radioactivity	
Sampler's Name: LARRY DURS				Sampler's Signature: [Signature]							
Proj. No. 726				Project Name: EXTENDED RIGVEINING						Lab Sample ID (Lab Use Only)	
876.67130										10758-1	
Matrix	Date	Time	Identifying Marks of Sample(s)	VOA	AG 1 LI	250 ml	P/O				
SOIL	9/24	1207	W1 - MPC - 180'				X				
		1222	W1 - WPL - 185'				X				
W		1247	TRIP BLANK	X							
W			EQUIPMENT BLANK	X							
								-mfs) 6			
								mbl) 7			
Turn around time								* BTEX (602/8020), TPH (418.1 or 8015), VOLATILES (624/8240), IGNITABILITY, TOTAL LEAD (6010)			
Relinquished by: (Signature)				Date: 9/24		Time: 15:37		Received by: (Signature)		Date: 9/25	
Relinquished by: (Signature)				Date:		Time:		Received by: (Signature)		Date:	
Relinquished by: (Signature)				Date:		Time:		Received by: (Signature)		Date:	
Remarks: ① EM-110-2-1906 AP-2								② EM-110-2-1906 AP-2			
③ ASTM D-422								Client's delivery of samples constitutes acceptance of Incheape/TS-Dallas terms and conditions contained in the Price Schedule.			
Matrix				W - Wastewater				S - Soil			
Container				VOA - 40 ml vial				SD - Solid			
				A - Air Bag				L - Liquid			
				250 ml - Glass wide mouth				P/O - Plastic or other			
				Priority 2 or 50%				Priority 4 ERS			
				Priority 3 or 100%				Priority 4 ERS			
				Priority 1 or Standard				Priority 4 ERS			

OFFICE USE ONLY

ORIGINAL



**Inchcape Testing Services**  
Environmental Laboratories

DATE RECEIVED: 2-Oct-1996

REPORT NUMBER: D96-11176

REPORT DATE: 22-Oct-1996

**RECEIVED**

SAMPLE SUBMITTED BY : Parsons Engineering Science

ADDRESS : 9404 Genesee #140  
La Jolla, CA 92037

ATTENTION : Mr. Larry Dudas

PROJECT : 726876.67130 WAFB-ST12

DATE SAMPLED : 30-Sep-1996

**OCT 30 1996**

PARSONS ENGINEERING  
SCIENCE, INC. - LA JOLLA

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**CASE NARRATIVE COMMENTS:**

The samples designated for the Soil Moisture and Bulk Density analyses were sub-contracted to another laboratory for testing. The results were reported in the sub-contracted laboratories format.

Due to insufficient sample volume, the total solids analysis was not performed.

No issues were encountered during the sample analysis of this job.

If you have any questions, please call Ms. Jacqueline Mayhew at (972) 238-5591.

  
Amy Pence  
Data Review/QC



# Inchcape Testing Services

## Environmental Laboratories

1089 E. Collins Blvd.  
Richardson, TX 75081  
Tel. 214-238-5591  
Fax. 214-238-5592

### ANALYTICAL REPORT

DATE RECEIVED : 2-OCT-1996

REPORT NUMBER : D96-11176-  
REPORT DATE : 22-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science  
ADDRESS : 9404 Genesee #140  
          : La Jolla, CA 92037  
ATTENTION : Mr. Larry Dudus  
PROJECT : 726876.67130 WAFB-ST12

Included in this data package are the analytical results for the sample group which you have submitted to Inchcape Testing Services for analysis. These results are representative of the samples as received by the laboratory.

The information contained herein has undergone extensive review and is deemed accurate and complete. Sample analysis and quality control were performed in accordance with all applicable protocols. Any deviations from these protocols or observations of interest are detailed in an accompanying Case Narrative. Please refrain from reproducing this report except in its entirety.

If you have any questions regarding this report and its associated materials please call your Project Manager at (214) 238-5591.

We appreciate the opportunity to serve you and look forward to providing continued service in the future.

Martin Jeffus  
General Manager





**Inchcape Testing Services**  
Environmental Laboratories

DATE RECEIVED : 2-OCT-1996

REPORT NUMBER : D96-11176-1

REPORT DATE : 22-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science  
ADDRESS : 9404 Genesee #140  
: La Jolla, CA 92037  
ATTENTION : Mr. Larry Dudas

SAMPLE MATRIX : Soil  
ID MARKS : WI-ST12-MPB-60'  
PROJECT : 726876.67130 WAFB-ST12  
DATE SAMPLED : 30-SEP-1996  
ANALYSIS METHOD : EPA 8020 /1  
ID MARKS : WI-ST12-MPB-60'  
ANALYZED BY : MKS  
ANALYZED ON : 7-OCT-1996  
DILUTION FACTOR : 1000  
METHOD FACTOR : 1.0  
QC BATCH NO : 1007802001

BTEX ANALYSIS				
TEST REQUESTED	DETECTION LIMIT		RESULTS	FLAG
Benzene	2000	µg/Kg	5800 µg/Kg	D
Toluene	2000	µg/Kg	72600 µg/Kg	D
Ethyl benzene	2000	µg/Kg	48700 µg/Kg	D
Xylenes	2000	µg/Kg	172000 µg/Kg	D

QUALITY CONTROL DATA			
SURROGATE COMPOUND	ACCEPTANCE CRITERIA	SPIKE RECOVERED	FLAG
Bromofluorobenzene (SS)	68 - 131 %	130 %	D



DATE RECEIVED : 2-OCT-1996

REPORT NUMBER : D96-11176-1

REPORT DATE : 22-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science

ADDRESS : 9404 Genesee #140

: La Jolla, CA 92037

ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Soil

ID MARKS : WI-ST12-MPB-60'

PROJECT : 726876.67130 WAFB-ST12

DATE SAMPLED : 30-SEP-1996

PREPARATION METHOD : EPA 3550A

PREPARED BY : PSS

PREPARED ON : 7-OCT-1996

ANALYSIS METHOD : EPA 8015M /1

ID MARKS : WI-ST12-MPB-60'

ANALYZED BY : VHL

ANALYZED ON : 10-OCT-1996

DILUTION FACTOR : 1

METHOD FACTOR : 1.0

QC BATCH NO : AB902-47

TPH BY GC (EXTRACTABLE)			
TEST REQUESTED	DETECTION LIMIT	RESULTS	FLAG
Total Petroleum Hydrocarbon	10.0 mg/Kg	2090 mg/Kg	

QUALITY CONTROL DATA			
SURROGATE COMPOUND	ACCEPTANCE CRITERIA	SPIKE RECOVERED	FLAG
Triacontane (SS)	60 - 140 %	80.2 %	



**Inchcape Testing Services**  
Environmental Laboratories

DATE RECEIVED : 2-OCT-1996

REPORT NUMBER : D96-11176-1

REPORT DATE : 22-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science

ADDRESS : 9404 Genesee #140

: La Jolla, CA 92037.

ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Soil

ID MARKS : WI-ST12-MPB-60'

PROJECT : 726876.67130 WAFB-ST12

DATE SAMPLED : 30-SEP-1996

MISCELLANEOUS ANALYSES				
TEST REQUESTED		DETECTION LIMIT	RESULTS	FLAG
Total Solids	/1	0.01 %	87.7 %	
Analyzed using ASTM D2216 mod. on 11-OCT-1996 by SAB QC Batch No : 1011221601				



DATE RECEIVED : 2-OCT-1996

REPORT NUMBER : D96-11176-2

REPORT DATE : 22-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science

ADDRESS : 9404 Genesee #140

: La Jolla, CA 92037

ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Soil

ID MARKS : WI-ST12-MPB-85'

PROJECT : 726876.67130 WAFB-ST12

DATE SAMPLED : 1-OCT-1996

ANALYSIS METHOD : EPA 8020 /1

ID MARKS : WI-ST12-MPB-85'

ANALYZED BY : MKS

ANALYZED ON : 7-OCT-1996

DILUTION FACTOR : 500

METHOD FACTOR : 1.0

QC BATCH NO : 1007802001

BTX ANALYSIS			
TEST REQUESTED	DETECTION LIMIT		RESULTS
Benzene	1000	µg/Kg	11500 µg/Kg
Toluene	1000	µg/Kg	66600 µg/Kg
Ethyl benzene	1000	µg/Kg	32900 µg/Kg
Xylenes	1000	µg/Kg	110000 µg/Kg

QUALITY CONTROL DATA			
SURROGATE COMPOUND	ACCEPTANCE CRITERIA		FLAG
Bromofluorobenzene (SS)	68 - 131	%	129 %



DATE RECEIVED : 2-OCT-1996

REPORT NUMBER : D96-11176-2

REPORT DATE : 22-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science

ADDRESS : 9404 Genesee #140

: La Jolla, CA 92037

ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Soil

ID MARKS : WI-ST12-MPB-85'

PROJECT : 726876.67130 WAFB-ST12

DATE SAMPLED : 1-OCT-1996

PREPARATION METHOD : EPA 3550A

PREPARED BY : PSS

PREPARED ON : 7-OCT-1996

ANALYSIS METHOD : EPA 8015M /1

ID MARKS : WI-ST12-MPB-85'

ANALYZED BY : VHL

ANALYZED ON : 10-OCT-1996

DILUTION FACTOR : 1

METHOD FACTOR : 1.0

QC BATCH NO : AB902-47

TPH BY GC (EXTRACTABLE)			
TEST REQUESTED	DETECTION LIMIT		FLAG
Total Petroleum Hydrocarbon	10.0	mg/Kg	1070 mg/Kg

QUALITY CONTROL DATA			
SURROGATE COMPOUND	ACCEPTANCE CRITERIA		FLAG
Triacontane (SS)	60 - 140	%	74.1 %



**Inchcape Testing Services**  
Environmental Laboratories

DATE RECEIVED : 2-OCT-1996

REPORT NUMBER : D96-11176-2

REPORT DATE : 22-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science

ADDRESS : 9404 Genesee #140

: La Jolla, CA 92037

ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Soil

ID MARKS : WI-ST12-MPB-85'

PROJECT : 726876.67130 WAFB-ST12

DATE SAMPLED : 1-OCT-1996

MISCELLANEOUS ANALYSES					
TEST REQUESTED		DETECTION LIMIT		RESULTS	FLAG
Total Solids	/1	0.01	%	82.1	%
Analyzed using ASTM D2216 mod. on 11-OCT-1996 by SAB QC Batch No : 1011221601					



DATE RECEIVED : 2-OCT-1996

REPORT NUMBER : D96-11176-3

REPORT DATE : 22-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science

ADDRESS : 9404 Genesee #140

: La Jolla, CA 92037

ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Soil

ID MARKS : WI-ST12-MPB-65'

PROJECT : 726876.67130 WAFB-ST12

DATE SAMPLED : 1-OCT-1996

ANALYSIS METHOD : ASTM D421/D422 /1

ID MARKS : WI-ST12-MPB-65'

ANALYZED BY : KRH

ANALYZED ON : 13-OCT-1996

METHOD FACTOR : 1.0

QC BATCH NO : 1013D42101

GRADATION REPORT			
TEST REQUESTED	DETECTION LIMIT	RESULTS	FLAG
Gravel & Coarse Sand (> 2.00 mm)	0.1 %	< 0.1 %	U
Medium & Fine Sand (0.075 to 2.00 mm)		33.6 %	
Silt (0.005 to 0.075 mm)		49.4 %	
Clay/Colloids (< 0.005 mm)		17.0 %	



**Inchcape Testing Services**  
Environmental Laboratories

DATE RECEIVED : 2-OCT-1996

REPORT NUMBER : D96-11176-3

REPORT DATE : 22-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science

ADDRESS : 9404 Genesee #140

: La Jolla, CA 92037

ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Soil

ID MARKS : WI-ST12-MPB-65'

PROJECT : 726876.67130 WAFB-ST12

DATE SAMPLED : 1-OCT-1996

TOTAL METALS			
TEST REQUESTED	DETECTION LIMIT	RESULTS	FLAG
Iron /1		8440 mg/Kg	
Dilution Factor : 1 Prepared using EPA 3051 on 10-OCT-1996 by CEL Analyzed using EPA 6010A on 12-OCT-1996 by LSS QC Batch No : 14987			





**Inchcape Testing Services**  
Environmental Laboratories

DATE RECEIVED : 2-OCT-1996

REPORT NUMBER : D96-11176-3

REPORT DATE : 22-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science

ADDRESS : 9404 Genesee #140

: La Jolla, CA 92037

ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Soil

ID MARKS : WI-ST12-MPB-65'

PROJECT : 726876.67130 WAFB-ST12

DATE SAMPLED : 1-OCT-1996

MISCELLANEOUS ANALYSES					
TEST REQUESTED		DETECTION LIMIT		RESULTS	FLAG
Alkalinity	/1			150 mg/KgCaCO3	
Analyzed using SM 2320B Mod. on 10-OCT-1996 by BAF QC Batch No : 1010232001					
Moisture (Oven)	/1	0.01 %		21.1 %	
Analyzed using ASTM D2216 Mod. on 12-OCT-1996 by RJS QC Batch No : 1012221601					
Nitrogen, Total Kjeldahl	/1	50.0 mg/Kg		504 mg/Kg	
Dilution Factor : 1 Analyzed using EPA 351.3 on 11-OCT-1996 by BAF QC Batch No : 1011351301					
Total Phosphorus	/1	5.0 mg/Kg		296 mg/Kg	D
Dilution Factor : 50 Analyzed using EPA 365.3 Mod. on 16-OCT-1996 by KPP QC Batch No : 669060					
pH	/1			7.3 SU	
Analyzed using EPA 9045 on 11-OCT-1996 by BAF QC Batch No : 1011904501					
Total Solids	/1	0.01 %		78.9 %	
Analyzed using ASTM D2216 mod. on 11-OCT-1996 by SAB QC Batch No : 1011221601					



DATE RECEIVED : 2-OCT-1996

REPORT NUMBER : D96-11176-4

REPORT DATE : 22-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science

ADDRESS : 9404 Genesee #140

: La Jolla, CA 92037

ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Soil

ID MARKS : WI-ST12-MPB-105'

PROJECT : 726876.67130 WAFB-ST12

DATE SAMPLED : 1-OCT-1996

ANALYSIS METHOD : ASTM D421/D422 /1

ID MARKS : WI-ST12-MPB-105'

ANALYZED BY : KRH

ANALYZED ON : 13-OCT-1996

METHOD FACTOR : 1.0

QC BATCH NO : 1013D42101

GRADATION REPORT			
TEST REQUESTED	DETECTION LIMIT	RESULTS	FLAG
Gravel & Coarse Sand (> 2.00 mm)	0.1 %	< 0.1 %	U
Medium & Fine Sand (0.075 to 2.00 mm)		7.8 %	
Silt (0.005 to 0.075 mm)		76.2 %	
Clay/Colloids (< 0.005 mm)		16.1 %	



**Inchcape Testing Services**  
Environmental Laboratories

DATE RECEIVED : 2-OCT-1996

REPORT NUMBER : D96-11176-5

REPORT DATE : 22-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science

ADDRESS : 9404 Genesee #140

: La Jolla, CA 92037

ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Liquid

ID MARKS : WI-ST12-MPB-RB

PROJECT : 726876.67130 WAFB-ST12

DATE SAMPLED : 1-OCT-1996

ANALYSIS METHOD : EPA 8020 /1

ID MARKS : WI-ST12-MPB-RB

ANALYZED BY : CNA

ANALYZED ON : 9-OCT-1996

DILUTION FACTOR : 1

METHOD FACTOR : 1.0

QC BATCH NO : 1008802001

BTX ANALYSIS			
TEST REQUESTED	DETECTION LIMIT	RESULTS	FLAG
Benzene	1.0 µg/L	< 1.0 µg/L	U
Toluene	1.0 µg/L	< 1.0 µg/L	U
Ethyl benzene	1.0 µg/L	< 1.0 µg/L	U
Xylenes	1.0 µg/L	< 1.0 µg/L	U
BTX (total)		< 1.0 µg/L #	

QUALITY CONTROL DATA			
SURROGATE COMPOUND	ACCEPTANCE CRITERIA	SPIKE RECOVERED	FLAG
Bromofluorobenzene	74 - 112 %	109 %	

# Based upon Good Laboratory Practice, the result is rounded to the appropriate number of significant figures.



DATE RECEIVED : 2-OCT-1996

REPORT NUMBER : D96-11176-5

REPORT DATE : 22-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science

ADDRESS : 9404 Genesee #140

: La Jolla, CA 92037

ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Liquid

ID MARKS : WI-ST12-MPB-RB

PROJECT : 726876.67130 WAFB-ST12

DATE SAMPLED : 1-OCT-1996

PREPARATION METHOD : EPA 3520B

PREPARED BY : TAP

PREPARED ON : 7-OCT-1996

ANALYSIS METHOD : EPA 8015M /1

ID MARKS : WI-ST12-MPB-RB

ANALYZED BY : VHL

ANALYZED ON : 10-OCT-1996

DILUTION FACTOR : 1

METHOD FACTOR : 1.0

QC BATCH NO : AB902-39

TPH BY GC (EXTRACTABLE)			
TEST REQUESTED	DETECTION LIMIT	RESULTS	FLAG
Total Petroleum Hydrocarbon	0.50 mg/L	< 0.50 mg/L	U

QUALITY CONTROL DATA			
SURROGATE COMPOUND	ACCEPTANCE CRITERIA	SPIKE RECOVERED	FLAG
Triacotane (SS)	40 - 140 %	83.6 %	



**Inchcape Testing Services**  
Environmental Laboratories

DATE RECEIVED : 2-OCT-1996

REPORT NUMBER : D96-11176-6

REPORT DATE : 22-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science

ADDRESS : 9404 Genesee #140

: La Jolla, CA 92037

ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Liquid

ID MARKS : Trip Blank

PROJECT : 726876.67130 WAFB-ST12

DATE SAMPLED : 1-OCT-1996

ANALYSIS METHOD : EPA 8020 /1

ID MARKS : Trip Blank

ANALYZED BY : CNA

ANALYZED ON : 9-OCT-1996

DILUTION FACTOR : 1

METHOD FACTOR : 1.0

QC BATCH NO : 1008802001

BTEX ANALYSIS				
TEST REQUESTED	DETECTION LIMIT		RESULTS	FLAG
Benzene	1.0	µg/L	< 1.0 µg/L	U
Toluene	1.0	µg/L	< 1.0 µg/L	U
Ethyl benzene	1.0	µg/L	< 1.0 µg/L	U
Xylenes	1.0	µg/L	< 1.0 µg/L	U
BTEX (total)			< 1.0 µg/L	#

QUALITY CONTROL DATA			
SURROGATE COMPOUND	ACCEPTANCE CRITERIA		FLAG
Bromofluorobenzene	74 - 112	%	111 %

# Based upon Good Laboratory Practice, the result is rounded to the appropriate number of significant figures.



DATE RECEIVED : 2-OCT-1996

REPORT NUMBER : D96-11176-7

REPORT DATE : 22-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science

ADDRESS : 9404 Genesee #140

: La Jolla, CA 92037

ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Soil

ID MARKS : Method Blank (Liquid)

PROJECT : 726876.67130 WAFB-ST12

DATE SAMPLED : 2-OCT-1996

ANALYSIS METHOD : EPA 8020 /1

ID MARKS : Method Blank (Liquid)

ANALYZED BY : CNA

ANALYZED ON : 9-OCT-1996

DILUTION FACTOR : 1

METHOD FACTOR : 1.0

QC BATCH NO : 1008802001

BTX ANALYSIS			
TEST REQUESTED	DETECTION LIMIT	RESULTS	FLAG
Benzene	1.0 µg/L	< 1.0 µg/L	U
Toluene	1.0 µg/L	< 1.0 µg/L	U
Ethyl benzene	1.0 µg/L	< 1.0 µg/L	U
Xylenes	1.0 µg/L	< 1.0 µg/L	U
BTX (total)		< 1.0 µg/L #	

QUALITY CONTROL DATA			
SURROGATE COMPOUND	ACCEPTANCE CRITERIA	SPIKE RECOVERED	FLAG
Bromofluorobenzene	74 - 112 %	107 %	

# Based upon Good Laboratory Practice, the result is rounded to the appropriate number of significant figures.



DATE RECEIVED : 2-OCT-1996

REPORT NUMBER : D96-11176-8

REPORT DATE : 22-OCT-1996

SAMPLE SUBMITTED BY : Parsons Engineering Science

ADDRESS : 9404 Genesee #140

: La Jolla, CA 92037

ATTENTION : Mr. Larry Dudus

SAMPLE MATRIX : Soil

ID MARKS : Method Blank (Soil)

PROJECT : 726876.67130 WAFB-ST12

DATE SAMPLED : 2-OCT-1996

ANALYSIS METHOD : EPA 8020 /1

ID MARKS : Method Blank (Soil)

ANALYZED BY : MKS

ANALYZED ON : 7-OCT-1996

DILUTION FACTOR : 1

METHOD FACTOR : 1.0

QC BATCH NO : 1007802001

BTEX ANALYSIS				
TEST REQUESTED	DETECTION LIMIT		RESULTS	FLAG
Benzene	2.0	µg/Kg	< 2.0 µg/Kg	U
Toluene	2.0	µg/Kg	< 2.0 µg/Kg	U
Ethyl benzene	2.0	µg/Kg	< 2.0 µg/Kg	U
Xylenes	2.0	µg/Kg	< 2.0 µg/Kg	U

QUALITY CONTROL DATA			
SURROGATE COMPOUND	ACCEPTANCE CRITERIA		FLAG
Bromofluorobenzene (SS)	68 - 131	%	105 %



#### DESCRIPTION OF REPORTING FLAGS

- U - Indicates compound was analyzed for but not detected.
- J - Indicates an estimated value. This flag is used if the compound is detected but is below the Reporting Limit.
- D - Indicates all compounds in an analysis at a secondary dilution.
- N - Indicates presumptive evidence of a compound. This flag is only used for tentatively identified compounds where the identification is based on a mass spectral library search.
- E - Indicates the compounds whose concentration exceed the limit of the instrument or the Laboratory Information Management System. The concentration will be greater than the concentration listed.
- Q - Indicates the surrogate recovery is outside the defined QC limits.
- M - Indicates the matrix has interfered with the recovery of the surrogates.
- O - Indicates the surrogate was lost because of dilution.





REPORT DATE : 23-OCT-1996

REPORT NUMBER : D96-11176

SAMPLE SUBMITTED BY : Parsons Engineering Science  
ATTENTION : Mr. Larry Dudus

LABORATORY QUALITY CONTROL REPORT

ANALYTE	Benzene	Ethylbenzene	Toluene	m,p-Xylenes	o-Xylene
BATCH NO.	1008802001	1008802001	1008802001	1008802001	1008802001
LCS LOT NO.	AB709-51C	AB709-51C	AB709-51C	AB709-51C	AB709-51C
PREP METHOD	---	---	---	---	---
PREPARED BY	---	---	---	---	---
ANALYSIS METHOD	EPA 8020	EPA 8020	EPA 8020	EPA 8020	EPA 8020
ANALYZED BY	CNA	CNA	CNA	CNA	CNA
UNITS	µg/L	µg/L	µg/L	µg/L	µg/L
METHOD BLANK	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
SPIKE LEVEL	500	500	500	1000	500
SPK REC LIMITS	75.0 - 125	75.0 - 125	75.0 - 125	75.0 - 125	75.0 - 125
SPK RPD LIMITS	20.0	20.0	20.0	20.0	20.0
MS RESULT	520	536	543	1200	566
MS RECOVERY %	104	107	109	120	113
MSD RESULT	490	545	544	1220	571
MSD RECOVERY %	98.0	109	109	122	114
MS/MSD RPD %	5.94	1.67	0.18	1.65	0.88
BS RESULT	NA	NA	NA	NA	NA
BS RECOVERY %	NA	NA	NA	NA	NA
BSD RESULT	NA	NA	NA	NA	NA
BSD RECOVERY %	NA	NA	NA	NA	NA
BS/BSD RPD %	NA	NA	NA	NA	NA
DUP RPD LIMITS	---	---	---	---	---
DUPLICATE RPD %	NA	NA	NA	NA	NA
LCS LEVEL	50.0	50.0	50.0	100	50.0
LCS REC LIMITS	75.0 - 125	75.0 - 125	75.0 - 125	75.0 - 125	75.0 - 125
LCS RESULT	47.6	52.0	52.9	116	55.0
LCS RECOVERY %	95.2	104	106	116	110
SPIKE SAMPLE ID	11176-4	11176-4	11176-4	11176-4	11176-4
SAMPLE VALUE	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
DUP SAMPLE ID	---	---	---	---	---
DUP SAMPLE VAL/1	---	---	---	---	---
DUP SAMPLE VAL/2	---	---	---	---	---

NA

Not applicable



REPORT DATE : 23-OCT-1996

REPORT NUMBER : D96-11176

SAMPLE SUBMITTED BY : Parsons Engineering Science  
ATTENTION : Mr. Larry Dudus

LABORATORY QUALITY CONTROL REPORT

ANALYTE	Benzene	Ethylbenzene	Toluene	m,p-Xylenes	o-Xylene
BATCH NO.	1007802001	1007802001	1007802001	1007802001	1007802001
LCS LOT NO.	AB709-51C	AB709-51C	AB709-51C	AB709-51C	AB709-51C
PREP METHOD	---	---	---	---	---
PREPARED BY	---	---	---	---	---
ANALYSIS METHOD	EPA 8020	EPA 8020	EPA 8020	EPA 8020	EPA 8020
ANALYZED BY	MKS	MKS	MKS	MKS	MKS
UNITS	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg
METHOD BLANK	< 1.00	< 2.00	< 2.00	< 2.00	< 2.00
SPIKE LEVEL	50000	50000	50000	100000	50000
SPK REC LIMITS	70.0 - 130	70.0 - 130	70.0 - 130	70.0 - 130	70.0 - 130
SPK RPD LIMITS	25.0	25.0	25.0	25.0	25.0
MS RESULT	68500	88000	12400	206000	83300
MS RECOVERY %	114	110	108	123	112
MSD RESULT	70000	91400	12700	211000	86200
MSD RECOVERY %	117	117	108	128	118
MS/MSD RPD %	2.60	5.99	0.56	3.98	5.05
BS RESULT	NA	NA	NA	NA	NA
BS RECOVERY %	NA	NA	NA	NA	NA
BSD RESULT	NA	NA	NA	NA	NA
BSD RECOVERY %	NA	NA	NA	NA	NA
BS/BSD RPD %	NA	NA	NA	NA	NA
DUP RPD LIMITS	---	---	---	---	---
DUPLICATE RPD %	NA	NA	NA	NA	NA
LCS LEVEL	50.0	50.0	50.0	100	50.0
LCS REC LIMITS	70.0 - 130	70.0 - 130	70.0 - 130	70.0 - 130	70.0 - 130
LCS RESULT	49.1	50.0	49.4	104	48.5
LCS RECOVERY %	98.2	100	98.8	104	97.0
SPIKE SAMPLE ID	11176-2	11176-2	11176-2	11176-2	11176-2
SAMPLE VALUE	11500	32900	66600	82900	27300
DUP SAMPLE ID	---	---	---	---	---
DUP SAMPLE VAL/1	---	---	---	---	---
DUP SAMPLE VAL/2	---	---	---	---	---

NA

Not applicable



REPORT DATE : 23-OCT-1996

REPORT NUMBER : D96-11176

SAMPLE SUBMITTED BY : Parsons Engineering Science  
ATTENTION : Mr. Larry Dudus

LABORATORY QUALITY CONTROL REPORT

ANALYTE	Total Petroleum Hydrocarbon	Total Petroleum Hydrocarbon	Iron	Alkalinity
BATCH NO.	AB902-39	AB902-47	14987	1010232001
LCS LOT NO.	AB868-17	AB868-17	690913	9971
PREP METHOD	EPA 3520B	EPA 3550A	EPA 3051	---
PREPARED BY	TAP	PSS	CEL	---
ANALYSIS METHOD	EPA 8015M	EPA 8015M	EPA 6010A	SM 2320B Mod.
ANALYZED BY	VHL	VHL	GGD	BAF
UNITS	mg/L	mg/Kg	mg/Kg	mg/Kg
METHOD BLANK	< 0.500	< 10.0	< 10.0	<10
SPIKE LEVEL	2.50	83.3	100	4600
SPK REC LIMITS	35.0 - 115	30.0 - 150	60.0 - 140	90.0 - 110
SPK RPD LIMITS	25.0	25.0	30.0	35.0
MS RESULT	NA	87.5	F	4300
MS RECOVERY %	NA	105	F	88.0
MSD RESULT	NA	73.2	F	4200
MSD RECOVERY %	NA	87.9	F	85.9
MS/MSD RPD %	NA	17.8	F	2.50
BS RESULT	2.68	91.0	NA	NA
BS RECOVERY %	107	109	NA	NA
BSD RESULT	2.39	82.7	NA	NA
BSD RECOVERY %	95.6	99.3	NA	NA
BS/BSD RPD %	11.4	9.56	NA	NA
DUP RPD LIMITS	---	---	30.0	35.0
DUPLICATE RPD %	NA	NA	22.6	0.00
LCS LEVEL	---	---	100	174
LCS REC LIMITS	---	---	60.0 - 140	90.0 - 110
LCS RESULT	SEE_BS	SEE_BS	95.5	183
LCS RECOVERY %	SEE_BS	SEE_BS	95.5	105
SPIKE SAMPLE ID	---	11101-4	10656-1	10758-6
SAMPLE VALUE	< 0.500	< 10.0	10200	250
DUP SAMPLE ID	---	---	10656-1	10758-6
DUP SAMPLE VAL/1	---	---	12800	250
DUP SAMPLE VAL/2	---	---	10200	250

NA  
SEE\_BS  
F

Not applicable  
LCS and LCS Duplicate reported as BS and BSD.  
Not applicable due to high analyte concentration in the QC sample.



REPORT DATE : 23-OCT-1996

REPORT NUMBER : D96-11176

SAMPLE SUBMITTED BY : Parsons Engineering Science  
ATTENTION : Mr. Larry Dudus

LABORATORY QUALITY CONTROL REPORT

ANALYTE	Nitrogen, Total Kjeldahl	Total Phosphorus	pH
BATCH NO.	1011351301	669060	1011904501
LCS LOT NO.	9966	ERA 9966	9972
PREP METHOD	---	---	---
PREPARED BY	---	---	---
ANALYSIS METHOD	EPA 351.3	EPA 365.3 Mod.	EPA 9045
ANALYZED BY	BAF	KPP	BAF
UNITS	mg/Kg	mg/Kg	---
METHOD BLANK	<50	< 0.1	NA
SPIKE LEVEL	1000	4.00	---
SPK REC LIMITS	85.0 - 115	80.0 - 120	---
SPK RPD LIMITS	20.0	20.0	---
MS RESULT	868	F	NA
MS RECOVERY %	79.8	F	NA
MSD RESULT	910	F	NA
MSD RECOVERY %	84.0	F	NA
MS/MSD RPD %	5.13	F	NA
BS RESULT	NA	NA	NA
BS RECOVERY %	NA	NA	NA
BSD RESULT	NA	NA	NA
BSD RECOVERY %	NA	NA	NA
BS/BSD RPD %	NA	NA	NA
DUP RPD LIMITS	20.0	20.0	5.00
DUPLICATE RPD %	0.00	5.70	0.00
LCS LEVEL	475	6.26	9.08
LCS REC LIMITS	85.0 - 125	80.0 - 120	95.0 - 105
LCS RESULT	462	6.08	9.10
LCS RECOVERY %	97.3	97.1	100
SPIKE SAMPLE ID	10758-6	11176-3	---
SAMPLE VALUE	70.0	296	< 0.00
DUP SAMPLE ID	10758-6	11176-3	11176-3
DUP SAMPLE VAL/1	70.0	280	7.30
DUP SAMPLE VAL/2	70.0	296	< 0.300

NA  
F

Not applicable  
Not applicable due to high analyte concentration in the QC sample.



# ITS Environmental Laboratories

55 South Park Drive  
Colchester, VT 05446

75 Green Mountain Drive  
South Burlington, VT 05403

## Analytical Report

Inchcape Testing Services  
Environmental Laboratories  
1089 East Collins Boulevard  
Richardson, TX 75081

Date : 10/15/96  
ETR Number : 61911  
Project No.: 96000  
No. Samples: 2  
Arrived : 10/10/96  
P.O. Number: 11176

Page 1

Standard analyses were performed in accordance with Methods for Analysis of Water and Wastes, EPA-600/4/79-020,  
Test Methods for Evaluating Solid Waste, SW-846, or Standard Methods for the Examination of Water and Wastewater.  
All results are in mg/l unless otherwise noted.

Lab No./ Method No.	Sample Description/ Parameter	Result
315838	11176-3:10/01/96 (Soil)	
	D2937 In-Place Density	C
	D854 Specific Gravity	C
	QSOA Porosity B1 Calculation	C
315839	11176-4:10/01/96 (Soil)	
	D2937 In-Place Density	C
	D854 Specific Gravity	C
	QSOA Porosity B1 Calculation	C

### Comments/Notes

C = Procedure/analysis completed

< Last Page >

Submitted By :

*R. Munson McNeer*

Aquatec Inc.



55 South Park Drive  
Colchester, VT 05446**ITS****Intertek Testing Services**  
**Environmental Laboratories****Analytical Report****In-place Density by ASTM D 2937**  
**and**  
**Soil Moisture by ASTM D 2216**  
**Porosity by calculation**Client: NDRC  
ETR: 61911  
Job: ParsonsStart date: 11-Oct-96  
Final date: 14-Oct-96  
Analyst: RGF, CJA\*

	1	2
Sample No.	315838	315839
Sample ID.	11176-3	11176-4
Sample Wet Wt. (grams)	424.32	695.51
Container/Sample Wt. (Wet)	646.69	906.62
Container Wt.	222.37	211.11
% Moisture (dry Mass basis)	17.4%	26.7%
Pan Wt.	3.66	3.65
Pan/Wet Wt.	83.73	74.40
Pan/Dry Wt.	71.87	59.50
Sample Volume (cm <sup>3</sup> )	280.77	358.36
Sample Recovery	9.30	11.87
Container Diameter	6.20	6.20
Area	30.19	30.19
Dry Mass (grams)	361.47	549.04
In-place Density (g/cm <sup>3</sup> )	1.29	1.53
Specific Gravity	2.58	2.73
Porosity **	0.50	0.44

\* Porosity calculation corrected by CJA 4/16/97.

\*\* Porosity was calculated using the formula:  $n = 1 - (P_b/P_s)$  where  $n$  = porosity,  $P_b$  = density, and  $P_s$  = specific gravity.

No. 315838 had large stones which created large voids.

Submitted by:

*Christopher J. Anderson*Date: *16 April 97*

55 South Park Drive • Colchester, VT 05446 • Tel: 802-655-1203 • 802-655-1248

[illegible]

	W - Water	S - Soil	SD - Solid	L - Liquid	A - Air Bag	C - Charcoal tube	SL - Sludge	O - Oil
1 Matrix	WW - Wastewater	A/G - Amber / Or Glass	1 Liter	250 ml - Glass wide mouth				
2 Container	VOA - 40 ml vial							

**Inchcape cannot accept verbal changes.**  
**Please Fax written changes to**  
**214-238-5592**

OFFICE USE ONLY

**ORIGINAL**